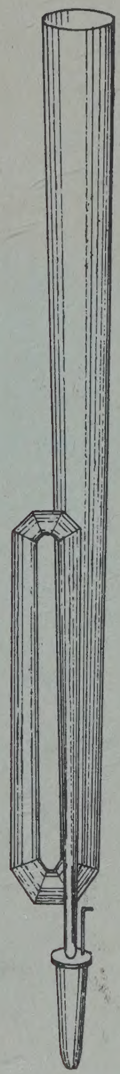
ODERN ORGAN STOPS

BY

NOEL A. BONAVIA-HUNT



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Henry Karl Baker
with the author's
kind regards
Noel Bonavia-Hunt
August 21st 1953

Preface

THE issue of this book is due wholly to the desire to place before the student a guide, sufficiently concise, and withal adequately comprehensive, to the clearer understanding of the science of organ tone-production. To the casual observer the alphabetical arrangement of stop-names would seem doubtless to convey the impression that yet a third dictionary of organ stops has been offered to the public. A closer scrutiny, however, should convince the reader that these pages do not seek to cover the same ground occupied by the excellent treatises of Wedgwood and of Audsley, but will, it is hoped, reveal the true aim and scope of the author. A number of stop-names have been deliberately omitted from the list, only those which have survived the ordeal of time and historic evolution and are still to be found engraved on the tablets of the modern organ have been selected for description and discursive treatment. A few exceptions to this rule may be seized upon by the carping critic : these are included for some definite reason which will clearly emerge after the perusal of the text, it may be in order that new light might be thrown on a matter of unusual interest, or that it was felt desirable to clear up some point in the evolution of tone. Apart from this, references to past endeavour and the question of origins are comparatively few, since this does not claim to be an historical treatise compiled for the benefit of the antiquarian.

The fascinating subject of *voicing* and all that appertains to that esoteric art has received more than usual attention. The practical student will find embodied in these pages much information (hitherto unpublished in any language) on the relative scaling of reed stops ; indeed, the whole subject of scaling, absolute and relative, has been dealt with as exhaustively as could be expected in a book of this limited size. Under the headings of CLARABELLA, DIAPASON and VIOLA will be found the broad outlines of treatment relating to the three great categories of flue tone, and likewise the subject of chorus reed tone is discussed under the headings

of TROMBONE, TRUMPET and TUBA. As these six articles in the aggregate form a kind of introduction to the study of all varieties of organ tone, the reader is recommended to assimilate their contents first of all.

A glossary of technical terms associated with the science of voicing (which is a branch of physics and should be studied as such) has been compiled for the benefit of those less advanced students to whom the reading of this work may from time to time present difficulties. The avoidance of technical expressions would be impossible in the exposition of any scientific subject, and experience has shown that it is better for the student to master the special terminology of the author than for the author to descend to the level of the student. Looseness of expression is unpardonable. It is hoped, also, that the illustrations will materially assist in elucidating the text, and that the reader will find them readily accessible for reference.

Lastly, the organ as a musical instrument can hardly claim to be excluded from the Aristotelian canon that "the nature of a thing is its finished development." We cannot rest contented with the present stage ot progress in tone and *ensemble* for all the wonderful improvements that have been introduced since the Victorian era. There are many schools of tonal design, each claiming to be the greatest; but in the organ of the future will be blended the best qualities of each school, and only with the perfection of all types will the ideal become the real.

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MODERN ORGAN STOPS

A practical Guide to their Nomenclature,
Construction, Voicing and Artistic use

WITH A

GLOSSARY OF TECHNICAL TERMS

relating to the Science of Tone-Production
from Organ Pipes

BY THE REVEREND

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(Author of "Studies in Organ Tone," "The Church Organ," &c.)

"*Omne tulit punctum qui miscuit utile dulci.*"—HORACE: "*Ars Poetica.*"

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Modern Organ Stops

Modern Organ Stops

Acoustic Bass.—The organ stop thus labelled represents the effort of the organ builder to produce the effect of a deep-pitched note such as is normally obtained from pipes of 16ft., 32ft., and 64ft. speaking length without resorting to such big and costly pipes. This acoustical illusion, as it may not inaptly be called, was first discovered two centuries ago by Tartini, and was introduced in a practical form by the Abt (Abbot) Vogler (1749-1814).

The phenomenon may be explained thus: sound the CC 8ft. note on the organ (for preference an open flue pipe) and sound along with it the fifth above, GG, $5\frac{1}{3}$ft. (preferably a stopped pipe): the effect of this sustained interval (CC and GG) should be to add to the unison note (CC) a soft yet distinct trace of the octave below (i.e., CCC, 16ft.). This experiment will prove the more successful if the two notes forming the interval of a fifth be produced from two pipes speaking very close to each other, their mouths pointing in the opposite direction, and if the lower note (CC) is fairly rich in overtones while the upper note (GG) is proportionately weaker and less equipped in overtones. Roosevelt and Gern have both demonstrated this with striking success by attaching the quint pipe (called a "monkey quint") to the unison pipe in such a way that both pipes are fed simultaneously from one common foot.

By a similar process, it is possible to secure a resultant 32ft. tone from the combination of the two notes CCC (16ft.) and GGG ($10\frac{2}{3}$ft.), and a 64ft. resultant by combining CCCC (32ft.) with GGGG ($21\frac{1}{3}$ft.)

Actually, the resultant note is not a sustained one. It is a rhythmical pulsation. For instance, the column of air in a 32ft. pipe vibrates approximately at the rate of 16 per second; that of a 16ft. pipe vibrates at the rate of 32 per second; and that of a $10\frac{2}{3}$ft. pipe at 48 per second. When both 16ft. and $10\frac{2}{3}$ft. pipes are speaking together, there are therefore 16 coincident vibrations per second; these vibrations being reinforced or accentuated correspond to the vibration number of a 32ft. pipe, and consequently produce a resultant pulsation at 32ft. pitch. This is also called a differential tone, because it is produced by difference of the vibration numbers of two combined notes. As the synchronisation of the vibrations occurs every $\frac{1}{16}$ of a second, the resultant 32ft. tone pulsates at the periodic rate of 16 per second, which is sufficiently rapid to account for the illusory effect.

Other intervals are employed by builders besides the fifth. The sub-quint or fourth below the unison, coupled to the unison, produces the faintest possible trace of the double octave below,—e.g., the $21\frac{1}{3}$ft., GGGG, sounded with the 16ft., CCC, gives a resultant 64ft. Walcker, the celebrated builder of Ludwigsburg, has for many years used the octave, tierce and superoctave as well as the quint, thus reinforcing the upper harmonics of a 32ft. violone.

Very often the quint and other ranks designed to accompany the unison are not independent sets of pipes, but are borrowed from existing pedal stops (or it may be from a 16ft. master stop on the manuals). Thus, a quint may take the form of a "quint coupler,"—that is, be derived from the pedal stopped 16ft. bass, or else the 16ft. open or stopped bass may be coupled in fifths. If the 32ft. open be carried down to GGGG, it is possible to couple this GGGG note to the 16ft. CCC when playing the CCCC pedal key, thus producing a 64ft. resultant. On the whole, modern expert opinion is adverse to the derivation of the quint from the same rank of pipes as the unison employed, unless it be the stopped bass, which allows of a more powerful unison bass, such as the open 16ft., being added. The question of the tempered interval is hardly worthy of consideration, since the unison in any case draws the subordinate note into accord with it. What is of importance is to see that the unison or prime note takes precedence in power and tone.

We may deduce from the above that the acoustic bass is employed by builders either from motives of economy or as a harmonic-corroborating device on the pedal (a species of grave mixture). Where money is not forthcoming or where height is inadequate for the accommodation of a real 32ft. stop, it is felt by a great number of architects that the acoustic illusion serves as a passable substitute, though the device should be restricted to the lowest octave of the 32ft. pedal stop. It is better still if the 32ft. pipes can be carried as far down the compass of the pedal board as FFFF, the bottom five notes being acoustic. As a matter of fact, the lowest five pipes of the real 32ft., whether open or stopped, are admittedly a doubtful investment when one realises that the effect of these notes is hardly commensurate with their great cost, and that there is a distinct fall-off in tone-value below FFFF, even with large scales. Hence the adoption of the resultant bass at this point has this much to commend it, especially for use in *forte* combinations. But if the complete compass 32ft. open can be afforded, there is still every advantage to be gained from the addition of a series of harmonic-corroborating ranks, such as the fifth, octave, tierce, septime and superoctave, while the sub-quint of $21\frac{1}{3}$ft. pitch will prove of inestimable value in the full pedal.

Æoline.—The prototype of this stop is the æolian harp, which is a delicate-toned stringed instrument designed to fit in a window frame for exposure to the wind, the effect of the wind blowing athwart the strings being to reproduce the sweet music of a distant string band. The name æoline, however, is also applied to a form of accordion introduced by Wheatstone before the concertina; this latter instrument would be the more correct prototype of the German reed stop bearing this name. In modern

organs the æoline is invariably an echo string stop, and not infrequently forms one of the ranks of the céleste *(q.v.)*. In the organ at St. John Baptist's Church, Holland Road, Shepherd's Bush, there is a very beautiful example of the æoline by Gern on the choir, consisting of two ranks of slow-beating pipes on an open soundboard; the *timbre* of this specimen, however, is not in the category of string tone, but is really that of an echo dulciana céleste or unda maris. The æoline of the modern builder is an echo viol, the scale at CC (8ft.) being approximately 2½in., and at tenor C (4ft.) 1½in., and in some examples smaller still. The mouth varies from a fifth to two-ninths of the pipe's circumference in width, and the pipe may or may not be slotted. The roller-bridge is essential, of course, and the voicing the same as that required for stops of the viol class (see under VIOLA).

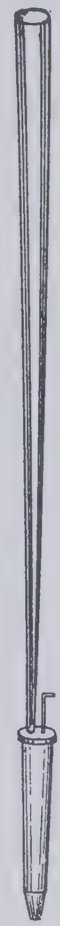
Baritone *or* **Baryton.**—See VOX HUMANA.

Basset Horn.—See CLARINET.

Bass Flute.—See STOPPED DIAPASON.

Bassoon.—The name given to a particular type of reed pipe employed for the lowest octave of the oboe and cor anglais *(q.v.)*: in other words, the distinctive tube of these stops is in the majority of cases not carried down below the 4ft. pipe. The scale of the bassoon tube at the top is usually 2½in. at CC (8ft.), this narrow diameter making the tone somewhat nasal. The shallot is narrow, with a V-shaped opening. Familiarly speaking, the bassoon is a small scaled trumpet *(q.v.)* reduced in power, the tubes being the same length in proportion to the scale. Regulating caps are generally soldered on the top of the tubes, or else the caps are completely soldered all round and a slot cut immediately below with a regulating tongue of metal. Wooden tubes are occasionally used.

As a 16ft. stop, the bassoon is generally assigned to the swell and pedal divisions, and is labelled variously "bassoon," "double bassoon," "fagotto," and "contra fagotto." The last name is sometimes adopted for the 16ft. trumpet or oboe-horn, especially when the tubes of the bass portion are half-length and capped at the top. The scale at CCC (16ft.) varies from 3⅞in. to 5in. Half-length reeds have an objectionable tendency to go out of tune with only slight changes of temperature, the "control" being obviously more difficult with the shorter resonator; but the margin for variation in consonance between tongue and tube is more defined if heavy wind pressure and relatively thick tongues are employed. The half-length tube, however, with the obvious exception of the 16ft.



BASSOON

clarinet, which is necessarily so constructed, should be avoided unless no alternative is possible.

Bell Gamba.—See VIOLA.

Bombarde.—In the modern organ this stop represents a smoothly voiced 16ft. reed of trombone or even tuba power, the scale at CCC (16ft.) being from 7in. to 8in. The tubes may also be of wood, with or without a cap. The 32ft. pedal reed is very often called "contra bombarde" or "contra bombardon." In modern organ design the high pressure division comprising the tubas, 16ft., 8ft., 4ft., with a series of *ripieno* harmonic ranks is known as the "bombarde division" (French: *clavier des bombardes*). This forms the "artillery" of the organ, is generally enclosed in a swell box, and made available on more than one clavier. (See also under TROMBONE.)

Bourdon.—A stopped pipe of 16ft. tone, nearly always made of wood, but occasionally to be found in metal or zinc. The 32ft. stop is called sub-bourdon. The pedal bourdon is frequently and advisedly labelled "sub-bass," the term bourdon being more properly restricted to the manual examples.

The manual bourdon is fast losing its popularity in this country in spite of the fact that Schulze was very partial to it on the great, and that at one time the swell was almost universally considered incomplete without it. To-day consensus of opinion seems to lie in favour of the *open diapason* as the most suitable double for the great diapason chorus, because the latter obviously extends the true diapason tone downwards just as the principal and fifteenth extend that tone upwards. It is therefore felt that if the bourdon or stopped double is to find a place in the great organ scheme at all, that place must be a secondary one, the relationship to the diapason chorus being similar to that of the 8ft. flute. The swell bourdon is still accorded the privilege of a place in the swell organ by some builders, although its inclusion is probably due to the desire to thicken up the softer flue stops of this department, and also to utilise the opportunity thus offered of deriving an expressive pedal bass from the same rank of pipes. The usefulness of the enclosed bourdon is exceedingly problematical. Confinement within a thick-walled chamber is the worst possible position for it, as even with the box fully open the bass octave is only just audible at the console (assuming the latter to be attached) while at a distance of (say) 30ft. from the organ it is very seldom audible at all. It is therefore more often than not waste of money to pack these pipes away in a box and to borrow them as an "echo bass" on the pedal. Nor is it possible to make expressive that which cannot be crescendoed, for it is but the multiplication of nought. Again, what is the artistic value of a rank of pipes that creates with the combinations of stops drawn with it a mere muddy precipitate? This is not organ tone, but a smudge of colours causing anything but pleasure to the analytical ear. Think, too, of the valuable space usurped by these bulky wooden pipes at the back of the swell box, space that could and should be far better occupied by other stops demanding precedence. If the bourdon is to be

enclosed at all, let the enclosed portion be confined to the tenor C register, let it be constructed of metal or zinc, and the 16ft. octave planted on a separate chest outside the box, regulated to the required power. For the scaling and voicing of manual stopped pipes the reader is referred to the remarks under STOPPED DIAPASON.

As a pedal sub-bass, the bourdon is of distinct value, and is moreover the most economical form of 16ft. toned stop, its half-length pipes rendering it especially amenable to restrictions of height. The chief difficulty experienced with it is its uncertain carrying power. It is not an exaggeration of the truth to say that the number of examples audible in all parts of the building in which they are designed to be heard is a very small percentage indeed. This is due to the fact that the sound waves project in great loops and are missed through dissipation unless in some way they can be disciplined by reflection. There are only two methods to which organ builders can resort for the solution of this problem. One is to make the pipes of large scale, the other is to plant them close to a reflecting surface. The question of scales is always a moot one: each builder has his own predilection. To steer between the "tubs" of the worthy Dr. Hayne, who advocated a scale of 13in. by 11½in. at CCC (16ft.), and the absurdly small scaling of certain German builders only fit for the lieblich category would seem to be following the dictates of sanity and common sense. If the English type of block and cap (see under STOPPED DIAPASON) be adopted, the scaling must be relatively larger than that which is appropriate to the Schulze formation of pipe. The author prefers the latter variety as giving a richer tone without in the least sacrificing the intensity of the prime partial. The smallest scale that can be guaranteed to produce a reliable and effective note is 8½in. by 6in. at CCC (16ft.). Schulze's well-known Hindley scale of 8in. by 5¾in. is certainly effective at Hindley and at other places where copies of the same pipe have been introduced; but success has not *invariably* attended the employment of this scaling in positions less advantageous than that at Hindley, so that one must plead this excuse for advocating as a minimum scale something larger. On the principle embodied in the familiar Latin saw *In medio tutissimus ibis*, it would be safer still to adopt a yet larger scale than the 8½in. by 6in. in accordance with the range of difficulties involved (such as those created by space and position). Anything between 10in. by 9in. and 8½in. by 7in. may be confidently recommended, whether the English or Schulze formation be used. With regard to the position of the pipes, as has already been hinted, close proximity to a reflecting surface is essential to good results. The reflector should be some kind of wall lined with some non-absorbent material such as cement, or it may be a casing of hard wood lined with zinc or painted with hard-drying enamel. It is not necessary to plant the pipes with their mouths facing the reflector, though this is probably the ideal arrangement: often the available floor space will not permit of this, and then the backs of the pipes have perforce to touch the wall. The minimum speaking room for a bourdon mouth is 4in. It is a great gain if the stop can be planted on the main floor of the building, so that the sound waves may as far as possible be focussed along it and thus

have a better chance of reaching the listener. This is not an easy matter when the organ is built *en bloc* on a gallery floor, but the advantage of the main floor position should not be lost sight of in the design of a new instrument, as it also applies with equal force to all pedal stops.

The voicing of the bourdon is a matter of importance in connection with its effectiveness as a pedal bass. It may safely be predicated that the higher the cut up of mouth the less likelihood there is of the tone travelling through every part of the building. On the other hand, the distressing tendency of these pipes to cough their twelfth prior to settling down to the prime is notorious. Reducing the wind supply only suppresses the twelfth at the expense of the prime. Increasing the height of the mouth also has its attendant dangers, two of these being unsteadiness of speech and windiness, a third having already been alluded to. With the scaling recommended above, these difficulties are reduced to a minimum. The mouth does not require to be cut up more than three-eighths of its width, and it is quite safe to cut up one-third only, increasing to three-eighths if necessary. Small scaled bourdons have to be cut up as much as three-quarters of the mouth width, or even more before the twelfth can be eliminated, or else the feet must be plugged up till what tone is left is unworthy of the pipe. Nobody knew better than the late Father Willis the value of a low mouthed bourdon as a tone traveller: unfortunately, he was too lenient with the twelfth, and thus spoilt the whole effect. The flue of the CCC (16ft.) pipe should not exceed $\frac{3}{32}$in.; the foot of the pipe should not be plugged unless absolutely necessary for regulation purposes; the upper lip should be at least $\frac{3}{8}$in. thick (the late T. C. Lewis was known to use a lip as much as $\frac{11}{16}$in. in thickness), and the planks of which the longer pipes are made should not be less than 1in. thick before being planed. The device sometimes adopted of leathering or felting the upper lip is entirely unnecessary if the pipe is properly constructed and finished; nor is there any special advantage to be gained from "clothing the flue," though it has been claimed by some voicers that this process intensifies the prime. There is, however, some justification for resorting to it in the case of heavy pressures, which are known to be inimical to the bourdon. In the ordinary course of things the bourdon should not be placed on a wind pressure exceeding 4in.; but if higher pressures are used it will be necessary to reduce the supply of wind at the foot in proportion to the sound-board pressure until a point is reached when plugging should make way for the process of leathering the lips. But nothing is to be gained from the deliberate adoption of heavy wind pressure, so far as the successful production of tone is concerned.

The idea of obtaining two distinct powers of tone from the same set of bourdon pipes has much to commend it provided that the pipes so treated do not extend higher than the 16ft. octave. Above this point in the compass the deviation from true pitch is too apparent to justify the economy. But it is the lowest octave that costs the most, so that a considerable saving of expense and space is effected by the process. Two ventil or drawstop boxes are attached to the same soundboard, the one trunked to the heavy pressure reservoir, the other to the light. The pipes are voiced to the higher pressure, and when the lower pressure wind is admitted to the chest the tone is feebler

though still distinct. Mr. John Compton, one of the most resourceful and artistic of English organ builders, many years ago introduced a clever yet simple compensating device by which the pitch of the stop on either pressure was maintained. This is not absolutely necessary if the two pressures are applied to the bottom octave of pipes only; and the upper portion of the stop can be derived from a manual stopped bass, or even a new set of pipes from CC added to complete the softer toned edition. In any case, such a device is more commendable than the more common one of duplicating the swell bourdon on the pedal as an echo bass.

The 32ft. bourdon (sub-bourdon) carries the 16ft. stop down a further octave to CCCC, but below FFFF the result is not by any means satisfactory when the cost of these big pipes is taken into consideration. A very safe scale for the FFFF pipe is 11in. by $9\frac{1}{2}$in., the mouth being cut up one-third of its width and fitted with a bridge or roller. A high mouth is fatal to success, and a low mouth encourages our old friend the twelfth: by applying the bridge the twelfth is brought under proper control and the prime is preserved as far as possible. The notes below FFFF are best obtained "acoustically" (see under ACOUSTIC BASS), the CCCC note, for instance, being produced by the coupling of the CCC and GGGG notes, or it may be better to derive the CCC note from an open 16ft. stop.

Mr. John W. Whiteley, the well known voicer, has adopted the ingenious device of obtaining two notes from one stopped pipe in the 32ft. and 16ft. octaves. The CCC pipe, for instance, is voiced to speak the 16ft. C note perfectly and to pitch: the CCC sharp key operates a circular disc valve which covers a circular hole bored in the back plank of the CCC pipe, immediately opposite the mouth, the diameter of this hole being equal to the height of the mouth. By pneumatically uncovering the hole, the exact semitone above is sounded.

Céleste.—See VOIX CÉLESTES.

'Cello.—See VIOLONCELLO and VIOLA.

Chimney Flute.—See ROHRFLÖTE.

Clarabella (also named Claribel or Claribel Flute).—The original stop, invented by J. C. Bishop, was simply the early English stopped diapason without its stopper, the scale being usually $1\frac{7}{8}$in. by $1\frac{5}{8}$in. at middle C (2ft.). The quality is that which can only be obtained from this formation of pipe, the large scale and low mouth combining to impart considerable foundation to the tone without the least approach to hardness. The beautiful Willis claribel flute on the great at Salisbury Cathedral is $1\frac{3}{4}$in. by $1\frac{7}{16}$in. at middle C; while the clarabella in the same division at All Saints, St. John's Wood, London, measures at this pipe 2in. by $1\frac{9}{16}$in.

As a solo stop, there can be no question as to its exceeding beauty, while it is not in the least upset (but rather assisted) by heavy pressure if properly adapted to it. But it is not a good mixer. With diapasons especially its companionship is undesirable, the old stopped pipe being far superior in

this respect. We have here, however, to discuss what is the most suitable form of flute for use in combination with pure organ tone. Various kinds of flute tone have been put on their trial by organ builders; indeed, it is not an exaggeration to say that nearly every firm of repute has its own particular type of claribel designed to form an integral part of the great flue chorus. Thus, one may find one firm of builders introducing the Bishop clarabella, another the inverted lipped wald flöte, another the harmonic metal flute, another the fundamental-toned metal flute with a high cut mouth, another the double mouthed wooden open or stopped flute (doppelflöte), another the large scaled claribel with leathered lip (tibia), another the large scaled metal stopped flute with leathered lip (tibia clausa), another the same in wood, and yet another the triangular hohl flöte of Schulze, with or without inverted mouth; and this list is not exhaustive by any means. Now, the question may fairly be asked: Which of these numerous types of flute best serves the purpose in view? The answer is, None of them, if any competition with the diapasons is aimed at. Pure organ tone in its ideal presentment is entirely capable of preserving its independence of assistance from flute tone; and, unless the latter is definitely subservient, may only too readily be injured by it. Hence no greater mistake could have been made than to include in the specification of the great organ an assertively voiced unison flute stop designed to cope with the diapason chorus. The hohl flötes of Schulze are by no means assertive, nor are the harmonic flutes of the late T. C. Lewis; and these two men appreciated the full value of pure organ tone. Provided, therefore, that the unison flute, be it open or stopped, of wood or metal, harmonic or otherwise, is treated as a subordinate voice in the diapason structure, the actual formation is of secondary importance.

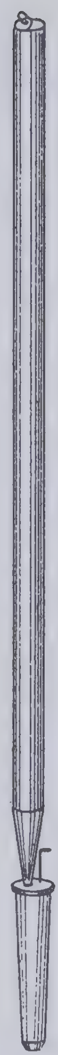
In the enclosed and orchestral divisions of the organ extreme latitude is admissible in the treatment of flutes, and each type may be found dealt with under their respective names. (See Corno Flute, Dolce, Doppel Flöte, Flauto Amabile, Flûte Ouverte, Harmonic Flute, Hohl Flöte, Lieblich Gedackt, Rohr Flöte, Stopped Diapason, Tibia, Wald Flöte.)

The clarabella is seldom used in octave pitch, though occasionally it may appear on the unenclosed choir division as a 4ft. stop under the name of "suabe flöte." The scale is two or three pipes smaller than the 8ft. stop.

The 16ft. clarabella frequently occurs on the pedal, but is never so labelled, the name of open diapason 16ft. being commonly (and incorrectly) assigned to it. The "tibia profunda" (quite a good name) of Hope-Jones is a large-scaled sub-clarabella with leathered lips (see Tibia).

Either the claribel or the diapason formation may be employed for the 32ft. open pipe: both are conspicuously successful down to FFFF, and from the actual note produced it would be almost impossible to discriminate between the two types in this particular octave.

Very frequently the open portion of the manual 8ft. claribel flute does not extend below 2ft. C; and in any case no advantage is to be gained from using open pipes below the 4ft. C, as the break between open and stopped pipes can be completely covered by a skilful voicer and finisher.



CLARINET

Clarinet (sometimes labelled Orchestral Clarinet, Cremona, Corno di Bassetto, Basset Horn).—The spelling "clarionet" is incorrect. This is a reed stop, voiced in imitation of its prototype. The tube is cylindrical in shape, and half the length of a trumpet tube, this formation suppressing the even harmonics in the same way as a stopped flue pipe does. The shallot has a V-shaped opening, the apex being cut about a distance of one-quarter from the head or base. The tongue is only slightly curved, the tuning length being kept as short as possible. There are three types of clarinet tone, each of them legitimate productions as variants. They are (1) the normal, round, woody *timbre* of moderate power, produced from a maximum scale of 1in. to $1\frac{1}{8}$in. at middle C with open tube; (2) the broad-toned, loud, basset horn or krummhorn type, produced from a large-scaled tube open at the top and sometimes surmounted by a conical bell; and (3) the thin, piquant *timbre* produced from a small-scaled tube, often capped at the top with a slot for regulation. The latter type, with a sufficiently reduced scale of tube, becomes a musette (*q.v.*)

The first type is the most generally useful, and should be prescribed where only one clarinet stop is permissible in the scheme of an organ. All types are the better for enclosure; and, although it is quite possible to voice good examples on low pressure, an increase of pressure enables the voicer to preserve the requisite smoothness when greater power is desired in an enclosed position.

The relative scaling of this stop is quite differently arranged from the normal ratio of progression for reeds, which halves on the thirty-second note. (See TRUMPET.) From CCC (16ft.) to BB (one note below tenor C) the usual reed scale ratio is employed; but from tenor C to C^8 the diameters very gradually diminish in what is known as "sevens and fives." Thus, supposing the scale of the tenor C (4ft.) pipe to be $1\frac{1}{4}$in., the next six pipes (T. C sharp to F sharp) are made to the same scale,—namely $1\frac{1}{4}$in., and at G the diameter becomes $1\frac{3}{16}$ in., and the next four (to B) are scaled the same, then middle C starts a fresh series of $1\frac{1}{8}$in. diameters, and so on to C in alt., after which the scale remains fixed to the top note. Some voicers prefer to stop the "seven and five" ratio at treble C and continue for the remainder of the compass with equal diameters; so that if the scale of treble C is $\frac{15}{16}$in., the rest of the pipes from this note are also $\frac{15}{16}$ in. Flue pipes are often used for notes above top D, owing to the difficulty of keeping the small half length reeds in tune. The conical tip is scaled by the same method: at middle C it is 2in. long, and the diameter at the tip is three-eighths to one-third of that at the top.

The following table of measurements shows the diameters and lengths of the tubes at the various C's:—

NOTE	DIAMETER	LENGTH (C = 517½)
CCC (16ft.)	2¼ in.	9ft. 4in.
CC (8ft.)	1¾in.	4ft. 7in.
T.C (4ft.)	1¼in.	2ft. 3in.
Mid. C (2ft.)	1⅛in. (often 1in.)	1ft. 1½in.
Treb. C (1ft.)	15/16 in.	6¾in.
C in alt (6in.)	13/16 in.	3⅝in.

The 16ft. octave is difficult to voice (as are all lower octaves of reed stops) and requires a very experienced artist. The tone of a well voiced bass is round and smooth, every note being regular and even. The tongues must be weighted at the end (the weights being regulated in accordance with the pressure of wind used and the general dimensions of each pipe and its various parts) from CCC to BB. The lengths of the tubes when open may be nicely adjusted by tin slides, which can be tapped up or down as required.

Some of the French examples, labelled cor de basset, clarinette, have inverted conical tubes capped at the top: the tone is, however, less smooth and imitative than that which is imparted by a cylindrical tube.

Clarion. — An octave trumpet or tromba, 4ft. on the manuals and 8ft. on the pedal. (See TRUMPET, TROMBA, TUBA.)

Concert Flute.—See HARMONIC FLUTE.

Contra.—A prefix indicating the stop as of suboctave pitch. Other prefixes bearing the same meaning are double, sub, gross.

Contra Bass.— Also named contra basso, double bass, violone. (See VIOLONE.)

Contra Fagotto.—See BASSOON.

Contra Gamba.—See VIOLA, VIOLONE.

Contra Hautboy.—See OBOE.

Contra Posaune.—See TRUMPET.

Contra Trombone.—See TROMBONE.

Contra Tuba.—See TUBA.

Contra Violone.—See VIOLONE.

Cor Anglais.—A reed stop imitating the tone of the orchestral instrument. In *timbre* it is allied to the oboe, but has a more hollow quality. Some idea of the tone may be gained by combining an 8ft. violoncello with a 4ft. stopped flute. The reed tube is that of a small-scaled oboe with the

Cor Anglais

exception that the bell at the top is of dual formation, being inverted conical like the oboe bell *plus* a conical portion soldered on the top of that; in other words, the bell first widens and then narrows. It is not capped: the regulating slot should be cut below the bell, or else a half-cap soldered on the top. The tongue and shallot are the same as those of the oboe, though some voicers employ the orchestral oboe shallot. (See ORCHESTRAL OBOE.) The scale, though always small, varies considerably. The tenor C (4ft.) tube may be an inch in diameter at the top at the point at which the bell is soldered on, while the bell may be $1\frac{3}{4}$in. at the widest point (centre) and $1\frac{1}{4}$in. at the top. This represents the minimum scaling. Some builders use the single bell, thus making their cor anglais pipe the same as other builders' orchestral oboe. At Bristol Cathedral, Walker used a half-length bassoon pipe completely capped at the top with a slot at a distance of two diameters below: the CC pipe is $1\frac{7}{16}$ in. scale, the length of the tube being 3ft. $7\frac{1}{2}$in. Perhaps the best form of all would be a small-scaled oboe tube and bell fitted with a domed cap and slotted immediately below the cap. A good scale at tenor C (4ft.) would be 2in. at the top of the bell, 1in. at the bottom, the tube being full length. The lowest octave (CC to BB) is often made of bassoon pipes, but whatever formation is adopted the stop should be carried down to CC. From top F up viol pipes may be used.

Cor Anglais (with domed cap)

Cor de Nuit.—See QUINTATÖN.

Cornet.—An obsolete mixture stop formed of large-scaled fluty-toned pipes, with the tierce rank topping the series, and intended for solo use. The inclusion of this stop in this work is really inconsistent with its aim, which is to deal with the stops of the modern organ only. It is mentioned, however, in view of the value that may be attached to the style of pipe employed in its composition, namely a full scale diapason pipe of the Father Smith type lightly blown,—an excellent recipe for fifth-sounding mutations. (See HARMONICS.)

Corno di Bassetto.—A large-scaled clarinet *(q.v.)*.

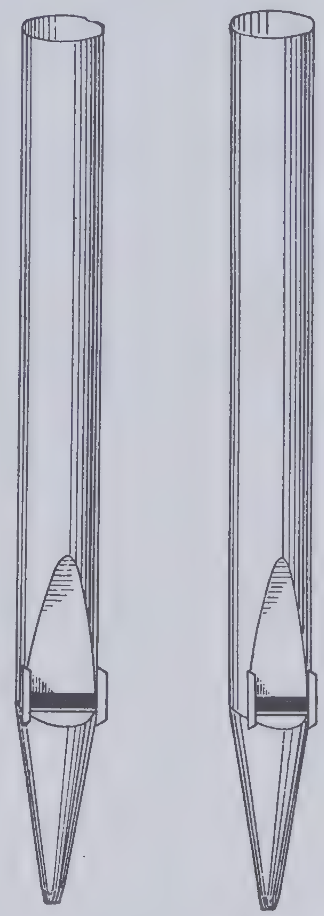
Corno Flute.—A flue stop invented by Mr. Herbert Norman, designed by him for use as a soft great organ accompanimental voice in place of the usual dulciana or dolce. It possesses an inverted languid (not nicked, of course), the top surface of which lies level with the lower lip-edge. The upper lip is arched and unflatted. The scale at middle C (2ft.) is $1\frac{1}{2}$in., the mouth being a fifth wide. The inverted languid is also used by Messrs. Hill, Norman & Beard for the bass and tenor octaves of some of their diapasons. The *convergent* flue thus formed helps to increase the quantity of wind discharged without retarding the speech.

Cornopean.—This is the cornet-à-piston of the orchestra, the tone of which is intermediate between the horn and the trumpet. The organ stop named cornopean was introduced by William Hill as the chorus reed of the swell division, and was simply a trumpet of slightly increased scale. The name cornopean was retained by Henry Willis for his own swell chorus 8ft. reed; but the tone of his reeds was more fiery and the scaling frequently that of the trumpet, the wind pressure being almost invariably 7in., as at St. Paul's Cathedral, London. The cornopean on the choir division of the fine organ at St. Saviour's, Ealing, London, by Willis is the freest-toned reed in that instrument; so that it can readily be inferred that the trumpet and cornopean were to that master practically interchangeable terms in connection with *timbre.* If, however, we are to be guided by the tone of the cornet-à-piston, the stop under consideration belongs of necessity to the category of modern smooth toned reeds introduced by Robert Hope-Jones (or, more truthfully speaking by Franklin Lloyd, a Willis-trained reed voicer who migrated to Hope-Jones's factory). At the same time, there would be some distinction between the cornopean and the horn, the latter representing in the domain of reed voicing the minimum of harmonic development. The true cornopean would presumably not contain a more prominent chord of harmonics than that which characterises the tuba or tromba of Willis, while it might conceivably contain less harmonics provided that some of the "clang tint" be retained. In the fine organ by Harrison & Harrison in St. Mary Redcliffe, Bristol, there may be found in the swell division an 8ft. trumpet and an 8ft. horn, both on 12in. wind, presenting a complete harmonic contrast,—the contrast that in the domain of flue work would be obtained from the juxtaposition of a clarabella and a geigen or 'cello. Somewhere between these two tonal extremes falls the cornopean and the tromba.

In the modern swell organ the chorus reed foundation is based on more or less free trumpet tone, the scale and treatment being modelled on that of Willis, whose swells have always owed their magnificence and fame to the gorgeous quality of the 16ft., 8ft. and 4ft. chorus trumpets. Hence the name cornopean should be abandoned in favour of trumpet for the foundation reed of the swell; and it is even questionable whether the title is needed at all in the modern organ when it is borne in mind that every type and shade of chorus reed tone can be comprehended in the names trumpet, tuba, tromba and horn.

Cremona.—A false and corrupt name given to the clarinet.

Diapason (also called Principal).—The name given to the principal flue stop of the organ, representing pure organ tone in all its pitches, especially from the 16ft. pipe up to the 6in. pipe. Diapason tone is peculiar to the organ as a musical instrument in that it finds no counterpart in the orchestra. All other tones in the organ are more or less imitative of or inspired by the tone of their orchestral prototypes: the diapason alone claims absolute independence of the orchestra. Hence the cinematic organ—designed to serve as an effective substitute for the cinematic orchestra, and often nick-named the "one man band"—has little or no scope for diapason tone, and indeed, in the opinion of many critics of repute, is better without it. The organ of classical and ecclesiastical tradition and development is, however, as little able to dispense with its diapasons as a violin to dispense with its strings. Pure organ tone is *par excellence* the "music of the vaulted shrine," possessing that mysterious quality of otherworldliness that "brings all heaven before one's eyes."



DIAPASON (2/7 mouth) DIAPASON (1/4 mouth)

The tone of the diapason stands midway between the two extremes of flute and string: it may sometimes incline towards the one, sometimes towards the other, but never can it cross the boundary line without losing its distinctive character. It partakes of some of the body and foundation of the flute category, while possessing a modicum of harmonic development known as the "natural string;" but the *timbre* is such that neither flute nor string tone is unduly favoured. Thus, the name diapason is the very best that could be given to it, the word signifying a standard or normal tone, all deviations from which are classed as variants. At the same time it has to be remembered that, strictly speaking, the diapason belongs to the order of flue or mouth pipes, and represents the basic tone of that *genus*, so that its relation to the combinational reeds of the organ is not determined without some difficulty. To say that the diapason holds the balance between flute, string and reed tone is to propound a theory of tonal architecture which in the modern organ is seldom if ever carried into practice. Such a theory, pushed to its logical terminus, would result in the relegation of chorus reed tone to a position of complete subordination in the tonal scheme;

for the most powerful of diapasons must yield to the overpowering personality of the modern heavy pressure trumpet or tuba. In the days when low pressures were in vogue and reeds and diapasons shared the same soundboard, the supremacy of the diapason was a natural and realisable conception. Nothing has proved more disastrous to the interests of true diapason tone than modern attempts to produce something that will successfully cope with the heavy pressure chorus reed. So far these heroic attempts have been thoroughly retrograde, pure organ tone having been sacrificed on the altar of foundationalism ; and all in vain, for the reed work still holds its own in the *ensemble*. The true solution of the problem is not to be found in these inartistic methods of bolstering up the flue foundation, but in the arrangement of a special reed chorus designed to balance the diapason chorus. We already have for this purpose the Willis swell organ, which is actually a secondary reed chorus under the control of the swell shutters. It is thus possible to create a perfect homogeneity by the combination of the unenclosed diapason organ and the enclosed reed organ ; for the diapasons can be made sufficiently powerful and the reeds sufficiently restrained, with artificial harmonics to balance both, without injury to either of these contrasting tone colours. The primary reed chorus, however, must be treated independently of the flue foundation : it then occupies the same position in organ tonal design as the brass occupies in the orchestra, its purpose being to supply climax effects. Thus it can be seen that the question of determining the relationship of the diapason to other tonal categories is bound up with the whole question of tonal architecture ; and the only reasonable conclusions at which it is possible to arrive are (1) that at all costs pure organ tone (that is, true diapason tone) must be produced within the limits of natural voicing, and a selection of all the other tones must be subordinated to it in such a way that it may hold the balance between them ; (2) that after this primary condition has been fulfilled, there can be no objection on artistic grounds to the provision of a specially powerful bombarde division designed for use in *fortissimo* combinations.

We must now speak of the unison diapason and its voicing. (The treatment and voicing of the octave ranks will be discussed under HARMONICS and DOUBLE DIAPASON.) There are four classes of diapason : (1) the early English, (2) the Schulze, (3) the geigen and (4) the modern English.

(1) The *early English* examples are familiar to most of us. They may be recognised by their peaceful character, singing light-heartedly on wind pressures of 2½in. to 3in. ; thin languids obtusely bevelled and lightly nicked, low-cut mouths readily overblowing to the octave on an increased pressure, straight-flatted lips, small foot-holes, scales ranging from 2½in. to 3½in. at the 4ft. pipe,—these are the chief characteristics of the *genus*. The proper place for such a diapason seems to be on the unenclosed "chayre" division of a church organ, though it makes a beautiful third or fourth open on the great where such exists. The author has reproduced the type in a number of organs, as for instance at St. Peter's Mission, Uxbridge, St. Barnabas, Southfields, St. Elizabeth's (R.C.) Church, Richmond. Messrs. Hele & Co. have recently introduced a specimen in their organ at the Abbey Church of

Buckfast (Devon). The title "early English diapason" was first adopted by the author in his earlier work, *Studies in Organ Tone*, where the construction of the pipe is described in detail. The secret, if there is one, lies in the obtuse bevel of the languid, the flat underlip, and the gentle supply of wind. Despite assertions to the contrary, Father Time adds his contribution in the finish-voicing of these diapasons.

(2) *Schulze diapasons* are to be found in the fine instruments voiced by that master at Armley, Hindley, Charterhouse, Tyne Dock, Doncaster, &c. Nearly every builder in this country has copied them with varying success. Their character is very striking; the tone is bold, singing and mellow. The upper partials are developed as far as the third (15th), never more, often less (as at Hindley), and there is never a suspicion of flutiness. At the root of Schulze's system lay the attempt to produce the maximum effect from low pressures. He made the foot-holes of the pipes very much larger than his contemporary English builders would have dreamed of doing: on the older type of pipe such a process would have utterly upset the speech. But the newer form of languid with its more acute bevel, introduced by Schulze into this country, made it possible to cut up the mouth to a greater extent without causing windiness and at the same time preventing the pipe overblowing to its octave or twelfth. Schulze, however, was averse from the practice of cutting up for pure organ tone, and in order to keep the note of his generously blown pipe on its prime harmonic and thoroughly sound in speech, he pulled the mouth outward, so to speak, instead of raising it: thus, by increasing the width rather than the height, the necessary mouth-area was provided. The standard width of mouth for diapasons is one-fourth of the pipe's circumference, and this was the width adopted by nearly all the old builders, the two-ninths width having been occasionally used. Schulze employed a width of two-sevenths almost invariably; for the large diapason he voiced for Leeds Parish Church he used four-fifteenths (very slightly narrower than two-sevenths), and a fourth mouth for the small diapason of that instrument. The two-sevenths mouth was cut up only a fourth of its width, and Schulze did not vary the cut up for varying wind pressures but altered the size of the foot-hole accordingly. On $2\frac{1}{2}$in. wind the foot-bore was enormous: the author well remembers the shock he experienced on seeing the bores of the upper octave pipes of the diapason and the mixtures belonging to the celebrated exhibition organ of 1851, voiced by Schulze on a wind pressure of $2\frac{1}{2}$in., the diameters of which were almost as large as the top of the pipe-body! The foot-hole diminishes with every increase of pressure, but not in the same ratio, since on the higher pressures (up to $3\frac{3}{4}$in.) the scaling of the pipe is enlarged with a view to adjusting the balance of parts. Up to $3\frac{3}{4}$in. of wind the two-sevenths mouth with the fourth cut up is capable of producing a pure diapason note of the finest quality, but beyond this limit (certainly on pressures of 4in. and upwards) the reduction of the area of discharge at the pipe-foot reaches a point at which it is no longer possible to retain the tonal characteristic. Even on $3\frac{3}{4}$in. it is questionable whether this mouth-area does not rather contribute a tendency to coarseness which would be noticeable in a non-resonant building,

so that in any case we would seem to have reached the parting of the ways at this point. Schulze himself appears to have detected this tendency, as in his famous Leeds example, which was voiced on this pressure, he reduced the mouth-width to four-fifteenths (as we have already seen), in order that he might make a slight increase in the cut up (to two-sevenths of the width). By this adjustment of the area he still retained the majesty of tone for which his diapasons are celebrated without any sacrifice of refinement. The two-sevenths mouth, however, is not an absolutely indispensable factor in the production of the Schulze characteristic: it is possible to obtain a magnificent tone from the standard fourth mouth appropriately cut up by treating the foot-bores in the same way and thus admitting the requisite quantity of wind to the pipes at a suitable pressure. A phenomenal instance of this may be seen and heard at Bredon Church (near Tewkesbury), where the great organ contains a large diapason with a fourth by two-sevenths mouth, the scale being the same as at Tyne Dock and Leeds, and voiced on a pressure of 3in. only. In this example the characteristic Schulze tone is faithfully reproduced.

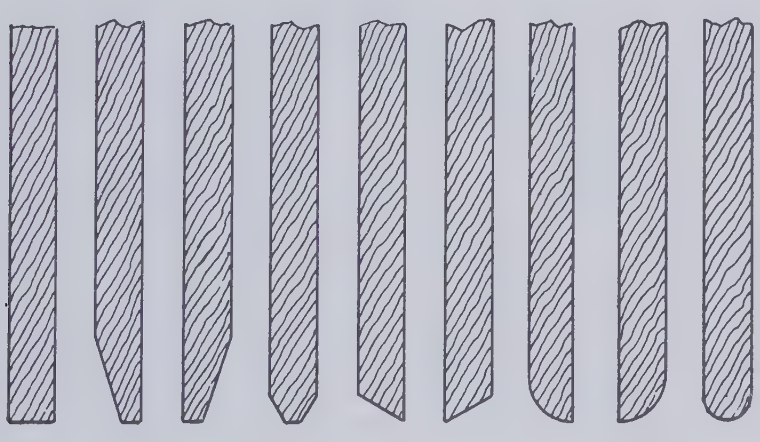
Other details connected with Schulze's diapason voicing may be briefly mentioned. The scaling varies from $2\frac{5}{8}$in. to $3\frac{3}{4}$in. at the 4ft. pipe. At Hindley (St. Peter's Church), the No. 1 diapason on the great is $3\frac{1}{4}$in.; at St. Bartholomew's, Armley, the major principal is $3\frac{1}{2}$in.; at St. Mary's, Tyne Dock, and at Leeds Parish Church the scale is $3\frac{3}{4}$in. The No. 2 diapason at Hindley is $2\frac{7}{8}$in. The CC to BB octave was frequently constructed in wood, Tyne Dock and Leeds being exceptions. The details of these pipes are given under DOUBLE DIAPASON.

The flatting of the lower lip was a departure from the more or less vertical form adopted by the early pipe makers. There is a distinct inward curve or convergence in the Schulze flatting, and this still represents the moderate curvature for general use to-day. The Willis "dubbed" lip yet further exaggerates the curve, and is chiefly of value in the domain of high pressure flue voicing. For the production of *cantabile* tone, the Schulze flatting cannot be improved upon.

The languid (as has already been pointed out) is acute-bevelled, this particular feature really forming the line of demarcation between ancient and modern flue voicing. A great characteristic of Schulze's voicing of diapasons is what is technically known as "slow speech." This does not mean that the pipe dragged its note or spoke with hesitation: it is but another expression for *cantabile* or singing tone, natural intonation, a something between slowness and quickness of speech yet perhaps inclined to slowness. The old English examples were quick speaking, but their individual charm possibly owes something to this, other factors being taken into consideration. The bolder tone of the modern diapason makes quick speech a defect, and the Schulze languid made *cantabile* voicing possible with increased power and brilliance. This is especially the case in the upper register, where quickness of speech is intolerable.

The treatment of the upper lip is a matter of great interest and importance. We shall appreciate Schulze's method better when we have realised the

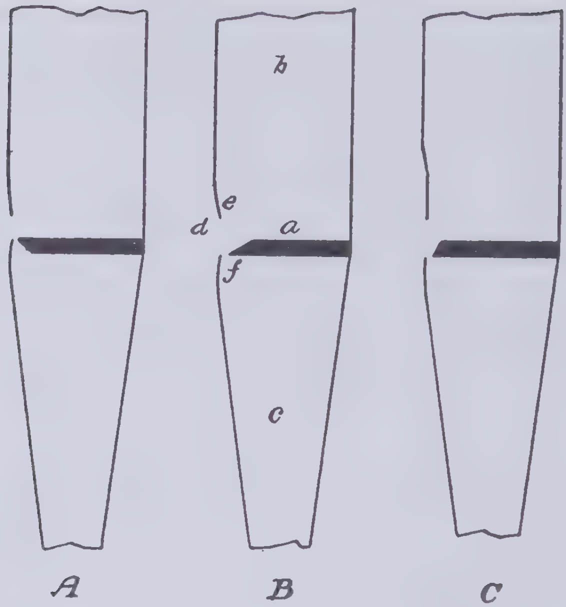
exact nature of the upper lip edge. It will not be out of place, therefore, to digress for a moment in order to study this point a little more closely. Let it be noted, then, that this upper lip (common to all flue pipes) possesses two distinct edges. Looking at the front elevation of the mouth, we may call these two edges the anterior and the posterior. Now, if it be borne in mind that either or both of these edges can be treated in one of three ways,—(*a*) bevelled, (*b*) sharpened, or (*c*) burnished, it will readily be perceived that there are no less than *nine* possible variations of type. The author was the first to make practical and systematic use of this knowledge in the voicing of metal flue stops, and more especially in the voicing of diapasons. Apart from the accidental effect caused by the covering of the entire lip with leather (first systematised by Hope-Jones), the idea of according any individual treatment to the *posterior* edge does not appear to have occurred to any voicer. The accompanying illustration shows in order the nine different



A B C D E F G H I

types of upper lip above referred to, numbered from A to I. A represents the normal unfinished lip after the process of cutting up, with both edges acute and a flat surface. B is the same lip bevelled at its anterior edge. C shows the posterior edge bevelled instead of the anterior. D has both edges bevelled. E exhibits an anterior bevel cut from front to back, thus leaving a sloping surface and a sharp posterior point. F shows the exact reverse, with a sharp anterior point. G has the anterior edge rounded (obtuse), with an acute posterior. H shows the reverse, with an obtuse posterior and an acute anterior edge. Lastly, I represents the rounded surface caused by the burnishing of both anterior and posterior edges.

Schulze adopted types B, E and G. Type E he used for the upper octaves of his diapasons, type B for all mixture ranks and for all geigens and string stops. The G lip he reserved for the tenor and middle registers of his diapasons, thus securing refinement of tone. The object of the bur-



INVERTED LANGUID — MODERN LANGUID — EARLY ENGLISH LANGUID

(*a*) languid (*b*) pipe body (*c*) foot (*d*) mouth (*e*) upper lip (*f*) lower lip and flue

nished edge, wherever it occurs, is to suppress all upper partials above the fourth harmonic (the fifteenth note above the prime), while retaining all the characteristics of pure organ tone.

Schulze's nicking was fine and shallow, the number of nicks diminishing as the scale increased, and *vice versâ*, the incision being deeper with heavier pressures.

The pipes were made of very substantial metal, with a goodly proportion of tin in the alloy. Spotted metal was employed for Tyne Dock and Leeds. It is agreed on all hands that thick metal walls resisting the internal vibrations of the column of air in the pipe are essential to the production of fine diapason tone.

(3) The *geigen*, also introduced into this country by Schulze, is grouped among the diapasons as possessing a larger proportion of pure diapason tone than string, despite its name (the German for violin). Harmonics are developed up to the eighth (or twenty-second note above the prime), so that possibly the name is justified. But the partials above the fourth are only faintly discernible, the adjustment being controlled by the wind supply admitted to the pipe rather than by the mouth-area. The tone is actually that of a small diapason voiced on the "free side;" the scaling is moderate, varying from $2\frac{1}{2}$in. to $2\frac{3}{4}$in. at the 4ft pipe, and the mouth is wide and low, usually from two-sevenths to a fourth of the pipe's circumference in width, cut up a fourth of its width, and bearded or rollered as required. The pipes are not

slotted; and the numerous examples of slotted geigens found in English work are in reality horn diapasons, in which the fifth and seventh harmonics are unduly developed. The true type of geigen is the ideal tone for octave diapason work from 4ft. up to the twenty-second. The reason for this is that the small scaling and low mouthing produce just that silvery quality which is required for these ranks. In the swell division, the geigen has been regarded for many years as the flue foundation, and in any case it may continue to be so regarded from the octave rank upwards.

(4) The *modern English diapason* has been evolved out of the desire for increased foundation and massiveness in the 8ft. register. We have seen how the Schulze diapason preserved the mean balance between the two extremes of tone, the flute being encouraged by the large mouth-area and the string by the large foot-hole. The phenomenal success that had already attended the application of high pressure wind-supply to chorus reeds by Henry Willis lured men on to experiment in the same direction with flue-work. It was soon discovered that the voicing of open flutes and, more especially, of string stops was greatly facilitated. The reason for this is explained in its proper place. It was considered an economic advantage, moreover, to be able to plant flue stops on the heavy pressure reed soundboard when desired without detriment to the tone. But in the case of the diapason the problem was not so simple as it might have appeared. High pressure means high velocity of discharge through the flue of the pipe; and high velocity facilitates overblowing. Therefore either the head of wind must be reduced at the foot-hole or else, if the fullest possible advantage is to be derived from the additional pressure, the scaling and the mouth-area must be adjusted to meet the situation, together with any special contrivances or dodges that may assist the voicer to solve the problem. It would be difficult to conceive of a more instructive experiment than to take a middle C diapason pipe with a large foot-hole (let us say $\frac{1}{2}$in. diameter) and see what is the maximum pressure of wind that can be discharged into the foot from the soundboard consistent with pure tone by modifying the scale, the mouth-area, the flue, and the style of the upper lip. It will be found that nature has ordained that certain boundaries shall not be transgressed, but the experiment will show us the limit of power that can be extracted from a diapason pipe and the relation of that power to musical tone. Before pursuing this line of thought further, however, it is necessary to have some idea of what is happening in the foot of an organ pipe when pressure-wind is flowing through it. This subject has been admirably treated in an article which appeared in the January and April (1922) numbers of *The Organ* by Mr. Alexander A. Jude, a well-known Birmingham engineer, in which, *inter alia*, he conclusively proved that the actual speaking pressure in the pipe-foot is less (often considerably less) than the pressure between the soundboard pallet and the foot-hole. It may be of interest to note, in passing, that Schulze by means of capacious pallet-holes, large grooves, direct vertical supply of wind to the pipe-foot through a large orifice, secured the highest comparative speaking pressure in relation to the reservoir pressure that has ever been achieved. The author has himself made various experiments with organ

pipes with the object of ascertaining the speaking pressure under differing conditions. Take, for example, a middle C diapason pipe, $2\frac{3}{16}$ins. diameter at the top, with a fourth mouth, cut up $\frac{1}{2}$in. Place it on a barred chest over a wind pressure of 3in., the diameter of the foot-hole being $\frac{1}{2}$in., and the area of the flue ·1in. The actual speaking pressure in the foot (ascertained by fitting the wind-gauge to a hole bored in the foot between the foot-hole and the flue) is 2·4in. Now load the reservoir to give a pallet pressure of 6in., and place the same pipe unaltered on the same soundboard hole. The speaking pressure will be 5in. The tonal result on 3in. is perfect,—pure organ tone: that on 6in. is obviously unhappy. Again, reduce the foot-hole of the pipe to $\frac{5}{16}$in., and the pressure in the foot will be 2·4in., the same as when the pipe was standing on 3in. with a $\frac{1}{2}$in. bore. The tone of the sustained note is the same as that of the low pressure example. It will at once be asked: Is there no difference between a high and a low pressure diapason voiced in either case to produce pure tone of equal power? Is the low pressure pipe with a large foot-hole and the high pressure pipe with a small foot-hole an interchangeable factor in the routine of voicing? The answer to this question is contained in the following statistics obtained by experiment n connection with the above-mentioned pipe. On 3in., with a $\frac{1}{2}$in. foot-hole this pipe speaks on a pressure of 2·4in. at the flue as has already been seen. But instead of holding down the key for a sustained note, let us try the effect of a series of taps on the key at the rate of four per second, and the actual pressure in the foot will now be reduced to 1·5in. Thus it will be seen that the attacking or repetition pressure, is much less than that of the sustained note. Placing the pipe with a $\frac{5}{16}$in. bore on 6in. pallet pressure, we get a sustained speaking pressure in the foot of 2·4in. as above mentioned, but the attacking pressure is only ·9in.! Here then we see the real difference between the two kinds of discharge: the high pressure pipe fills up at a slower rate per second than the low pressure one under the same conditions, and this is an important factor that the high pressure diapason voicer has to reckon with. It means that in order to secure the same *characteristically* prompt attack from a high pressure pipe, he has to make the speech quicker than would be necessary on a lower wind, and this bids fair to destroy the true character of the tone itself. The inference to be drawn from a practical study of what is happening in the pipe-foot during the passage of pressure-wind from pallet to flue may be stated thus: if we are to make the most of the soundboard pressure we must reduce the difference in the pressures at the pallet and in the foot and treat the pipe in such a way that the note produced is not disturbed or injured by the increased velocity. Except in special cases when no other pressure is available, there is no reasonable justification for the Procrustean method of placing a diapason on an excessive pressure with a very small foot-hole when the same effective pressure can be obtained from a lower pallet pressure by means of a larger orifice.[1]

[1] On a large soundboard constructed to hold a number of stops a certain margin of pressure in the groove chamber is desirable for the purpose of ensuring an adequate speaking pressure to every stop, but even this engineering precaution does not necessitate the wastage of energy inseparable from a certain modern school of voicing. For this reason the prevailing tendency among builders to place special high pressure stops on separate chests is to be commended and encouraged.

The whole question of high pressure diapason voicing resolves itself into one of massive power-production. The *raison d'être* of high pressure is or ought to be to generate something more than say 3in. in the pipe-foot. In order to solve the difficulty of high velocity and its influence over the static waves at the mouth of the pipe, voicers have adopted four expedients which though it is necessary for the sake of clearness to mention them separately are capable of use in combination. The first is to increase the mouth-area. It is generally considered to be more advantageous in high pressure voicing to reduce the width of the mouth and to cut up higher in proportion: the narrowed flue and closer proximity of the ears to one another facilitate quick speech, and the increased cut up is less likely to cut out the desirable harmonics. The second expedient is to increase the scale of the pipe. There is, of course, a point at which this cannot be done with impunity: let us suggest $4\frac{1}{2}$in. at the 4ft. tenor C pipe. But it has to be remembered that the question of absolute scaling is governed by that of relative scaling, that it is one thing to produce a successful note from any one pipe, another thing to carry that success to its ultimate terminus,—the complete stop. Abnormal scaling is a dangerous remedy to employ and leads to complications in the middle register which are liable to prove worse than the disease. Thirdly we have the famous device of coating the upper lip with splitskin or leather. It is not known to whom the flash of inspiration came, but the idea will always be associated with the name of Hope-Jones. To the fastidious engineering mind it is at best an expedient for doctoring up old pipes. The leathered lip effectually eliminates undesirable overtones and solves the speed trouble born of heavy pressures: at the same time it produces a different tonal characteristic, the principal feature of which is smoothness. If the only desideratum in a diapason be the attainment of a massive foundation-tone, this, admittedly, is a safe way to realise it. But the unison diapason is a member of its family even though it be the parent, and its obligations are considerably greater than those of the flute, for example. When we add the octave member to the unison we should expect a true octaval extension of pure organ tone. If either (or both) the unison and the octave possess an inadequate harmonic development, the cohesion breaks down. It is not generally realised that the octave diapason does something more than merely add brightness in combination: it is possible to treat the two ranks in such a manner that the parent rank is actually reinforced by the combination. To make this point quite clear, let us suppose that the unison diapason is voiced on the "string" side, and that when sounded alone the harmonic development is a little too pronounced (especially when heard at close quarters): now let the octave (also voiced on the "string" side) be added and observe the result. The string *timbre* of the unison rank will immediately disappear (apparently these overtones are absorbed by the octave rank), while the foundation-tone of this rank will appear to receive corroboration. The octave diapason will shoot out (as it were) its own harmonics in an *upward* direction, making full preparation for the introduction of the next member of the family. The leathered diapason under artistic hands possesses many excellent qualities, and it is possible to conceive of special circumstances

in which a place might be found for it in an organ scheme; but its distinctive individuality stands in the way of its social effectiveness, especially in company with reeds and upper work. There remains one further expedient to the voicer of high pressure diapasons. The genius of Vincent Willis, one of a family of geniuses, has discovered for us the "double languid." Illustrations of this form of languid will be given. The narrow space between the two languids, called the "false flue," is open to atmosphere either in the pipe-body itself or through an orifice bored in the back of the pipe directly opposite the mouth: this creates an induced draught of outside air at the mouth which opposes the stream of pressure air issuing from the (real) flue and thus materially affects the static wave-front, increasing its amplitude and the frequency of its vibrations. The result is bigger tone, quicker speech, and an increase of overtones. Mr. Vincent Willis's own experimental pipes (which are in the author's possession) were voiced on $3\frac{1}{2}$ in. of wind, and he also made and voiced a complete tenor C stop on this pressure. The author has placed a middle C pipe with induced draught derived from the pipe-body (the scale being $2\frac{1}{2}$in., the mouth two-ninths width, the area of the flue ·125in., the diameter of the foot-hole $\frac{1}{2}$ in.) on a soundboard pressure of 3in. The speaking pressure in the foot was 2in., and the attacking pressure 1in. The same pipe with the same foot-bore placed on 6in. wind gave the following anemometrical results: speaking pressure, 4·4 in.; attacking pressure 2·2in. With the foot-hole reduced to $\frac{5}{16}$in. the pipe spoke with difficulty even on a 6in. pallet pressure, the speaking pressure being only 1·4in., and the attacking pressure ·7in. It will be seen, therefore, that the double languid has the effect, as one would have expected, of reducing the foot-pressure somewhat, but rather helps on the attack. Unfortunately the chord of harmonics produced by this special device is too pronounced in proportion to the increase of power to ensure for this type of diapason anything approaching normal use. The application of high pressure to the double languid pipe was first made by Mr. Henry Willis, jun., who has placed two examples on 12in. wind in the fine organs built by the famous house for Hanley Town Hall and Westminster Cathedral respectively. For buildings of abnormal size where an unusually large body of pure organ tone is required to support a vast congregation of singers, the double languid has offered the only serious contribution towards solving the problem. Nothing really takes the place of diapason tone on these occasions. The high pressure double-languid stops referred to above are the first examples employed in a practical form in the organ, and doubtless the new Liverpool Cathedral organ will provide an opportunity for a further development of the type. The following are the particulars of the Westminster stop: tenor C pipe, 4ft., scale $4\frac{1}{4}$ in., mouth two-ninths width cut up four-elevenths of its width, induced draught from the pipe-body, diameter of foot-hole, $\frac{17}{32}$in. Supply pressure, 12in. The tone of this specimen is very big indeed, the most striking feature being the combination of foundation and string, both of which are duly represented without detriment to the other. For a building possessing little resonance the harmonic development would be excessive, but it needs no prolonged study of acoustics to realise the fact that there is a type of building which

demands heroic measures from the voicer if the net result of his efforts is to prove even adequately successful. In such places the leathered phonon, despite the carrying power attributed to it by its advocates is hurled into the category of flute tone, and an exaggeration of the natural overtones is translated into colour and vivacity. It is not too much to say that no one can expect to design the most effective diapason for a given building who has not first of all tested the distinctive acoustical properties of that building by listening to an experimental chord of pipes at various distances and carefully noting the results.

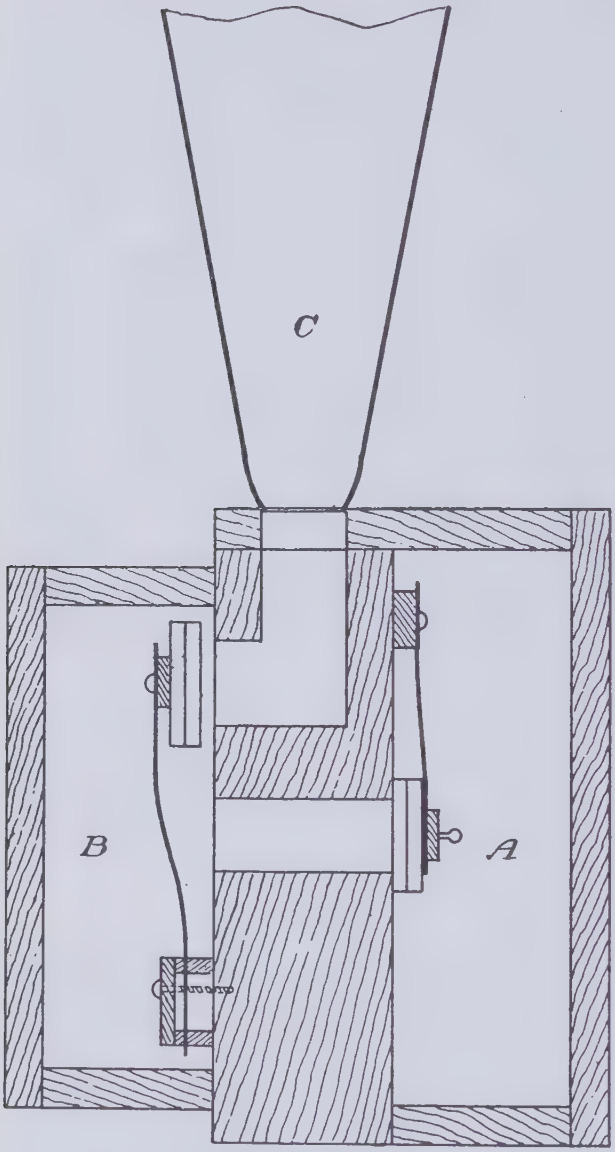
Whatever arguments may be urged in favour of high pressure for the production of massive power and foundation for abnormally large buildings, these arguments do not apply with equal force to the treatment of the normal diapason for normal buildings. It is not only possible, but quite easy, to obtain a fine volume of pure tone from a diapason whose scale does not exceed $3\frac{7}{8}$ in. or 4in. at the 4ft. pipe on a soundboard pressure of $3\frac{3}{4}$in., provided that the foot-pressure is not inordinately choked off and the mouth is artistically treated. As has been indicated above, the style of upper lip employed is of supreme importance and must be adapted to its environment. For non-resonant buildings, type I, the all-round lip, is best. It is not, however, the province of this book to lay down any hard and fast rules for the production of the ideal diapason, but rather to state in briefest outline the *pros* and *cons* of the various methods which have been employed by voicers past and present, all of whom without exception have striven to attain one step nearer to the goal of perfection.

Diapason Phonon.—The massive fundamental-toned diapason which Robert Hope-Jones introduced into the majority of his organs. It is voiced on heavy wind pressure (usually 10in.), with its upper lip (and sometimes even its flue) clothed with thin leather. Probably no better examples exist in this country than on the great at Worcester Cathedral, and on the swell at Burton-on-Trent Parish Church. (See under DIAPASON.)

Diapason, Stopped.—See STOPPED DIAPASON.

Diaphone.—A pedal stop belonging to the beating reed order introduced in a crude form in the year 1888 by Blackett & Howden, of Newcastle, and further developed by Robert Hope-Jones in 1893 and subsequently. The latest form of diaphone is known as the "valvular reed" and is the only type in use at the present day. The original examples possessed pneumatic starters in the form of motors (bellows), which were fitted in much the same way as in the case of the 32ft. reed. The modern pattern of diaphone has a vibrating valve (a circular disc) carried on the free end of a steel spring, and the motor bellows is dispensed with. The figure on p. 24 makes this clear without further verbal description.

The operation of the valve is best understood by comparing it with that of an ordinary 16ft. reed tongue. The latter, during the process of striking against the shallot, *gradually* covers and uncovers the opening; while the diaphonic disc-valve, designed to cover a circular orifice, closes every part of



Valvular Diaphone

A Pallet box
B Sound box, with Vibrator
C Resonator

that orifice simultaneously with each stroke and as simultaneously uncovers it on the recoil. The periodic internal shocks in the diaphonic resonator are consequently much greater than in a reed tube, and the result is increased tonal output, especially when high pressure is used. By varying the scales of the resonators at the tip as well as at the top, and by adjusting the area of the valve-hole, it is possible to reproduce the qualities of different flue and reed basses such as the 16ft. salicional or dulciana, the violone, the open diapason bass, and the trombone. Mr. John Compton has shown what can be done in this respect in his fine instruments at Uxbridge (at the residence of Mr. A. H. Midgley) and at the Pavilion Cinema, Shepherd's Bush. In the latter organ there is a diaphonic "tibia bass," the resonators of which are of half length clarinet shape of large scale. For the production of close, smooth tone the disc-valve is weighted and the spring shortened as in the case of a

reed tongue similarly treated; while a freer tone is obtained by a longer spring and a lighter valve. It is a risky proceeding to plant diaphone pipes on an ordinary soundboard, as it must be remembered that the soundboard is a chamber possessing a note of its own which may prove antagonistic to that of the diaphonic air chamber, thus upsetting the progressive scaling of the resonators. Mr. Compton so constructs the pallet box which supplies wind to the apparatus that no resonance is possible.

The diaphone will speak on any pressure. As the pressure is increased the power is increased correspondingly, and on the higher pressures the tone becomes very coarse when heard at close quarters.

The only real contribution the diaphone has made to organ tone is that of *weight* and massiveness in the 32ft. and 16ft. octaves. But this is by no means a contribution to be depreciated, for the tone of the diaphone is so intense that it is least of all organ stops influenced by enclosure or by confinement in a bad position. The prime note is considerably in evidence, so that in large buildings or in difficult acoustical conditions we have at our disposal a very valuable asset in the valvular reed. It, moreover, keeps in tune better than any ordinary reed, the variation in pitch between the diaphone and the flue work in these octaves being much less pronounced.

Dolce (also called Dolcan and Flauto Dolce).—16ft., 8ft. and 4ft. pitch. This is a soft metal flute of German origin introduced to us in 1741 by Snetzler at Chesterfield Parish Church, and later popularised by Schulze whose organs almost invariably contained an example. The pipes are inverted conical in shape, the diameter at the top of the body being approximately one-and-a-half times that at the mouth. The tenor C (4ft.) pipe varies from $1\frac{3}{4}$in. to $2\frac{1}{4}$in. at the mouth with the scale at the top in the proportion of 3 : 2. The mouth width is two-ninths or a fourth of the circumference at the top of the pipe. The tone of the dolce is precisely that of a fluty dulciana, the wide top imparting a *soupçon* of horniness to the *timbre* which makes it a very fair imitation of an echo waldflöte. The disadvantage of this shape of pipe consists in the amount of soundboard space it occupies, and as it is quite easy to reproduce the tone from a cylindrical pipe such as the corno flute (*q.v.*) or a dulciana of $2\frac{1}{4}$in. scale at tenor C with an arched mouth, the modern organ has practically dispensed with the German pattern as an unjustifiable extravagance.

DOLCE

Doppelflöte.—A wooden flute open or stopped, with two mouths placed on opposite sides of the pipe.

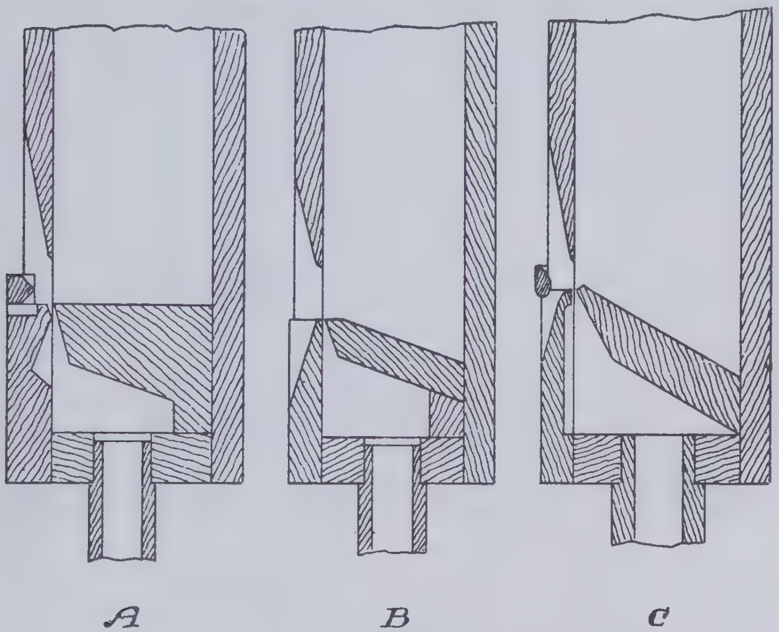
The stopped examples are quite the best, and the tone is surprisingly full in combination with other stops. It is also, as Dr. Audsley points out, an excellent thickener for the clarinet and oboe-horn. The scale varies with different voicers, but no better scale can be found than $2\frac{1}{8}$in. by $1\frac{3}{8}$in. at middle C (2ft.) The mouth-planks should be made of hard wood. The double-mouthed pipe demands more than the usual amount of speaking room on the soundboard, and in any case there is not the slightest advantage to be derived from carrying the double mouth below middle C. The proper home for the doppelflöte would seem to be in the solo division where it can be effectively used with other solo stops.

Double.—This prefix attached to a stop-name denotes the octave below. Double diapason means 16ft. diapason. Synonym,—sub and contra.

Double Diapason (frequently labelled "Double Open Diapason," often erroneously used as the name for the bourdon or double *stopped* diapason).—32ft. on the pedal, 16ft. on the manual. This stop is the suboctave member of the diapason family, and without it no great flue chorus can be complete. Very often (to save expense and make the most of the material in hand) the double diapason is borrowed as a 16ft. stop on the pedal and utilised in this latter department as a secondary diapason bass. Either metal or wood may be employed. For the metal pipe, zinc is quite good enough from CCC 16ft. to BB one note below tenor C, provided the remainder of the stop is made of stout plain metal. The scale at CCC varies from 12in. to 9in., the mouth being usually two-ninths in width. At CC the scale need never exceed 7in., while less than 6in. for a moderate-sized organ is not desirable. The mouth is cut up a third to four-elevenths of its width, and the upper lip and leaf should always be made of plain metal and soldered in. It is hardly necessary in these days to state that only hard-rolled zinc must be used. The 32ft. CCCC pipe may be anything from 15in. to 25in. in diameter. That at York Minster measures 20in. The scale of the new Liverpool Cathedral example is 23in., the thickness of the zinc sheet being $\frac{3}{16}$in instead of the usual $\frac{1}{8}$in.

The wood pipe CCC (16ft.) gives probably better results than the metal. It certainly does in the 32ft. octave. The scale of the CCCC pipe at Westminster Cathedral, by Willis, is 29in. by 25in., that at the Albert Hall, Nottingham, by Binns, is 27in. by $23\frac{1}{2}$in., that at Armley by Schulze is $18\frac{1}{4}$in. by $14\frac{1}{4}$in. These examples give a fair idea of the limits of scaling for practical purposes. The CCC pipe also varies in size in the same way. Pendlebury's scale at St. Paul's, Westleigh (Lancs.), may be accepted as the maximum: it is 13in. by $11\frac{1}{4}$in. A more serviceable scale is 12in. by 10in., it being cheaper to procure 12in. boards from the timber-merchant. For a really efficient manual double diapason it would be difficult to excel the result produced from a 10in. by 8in. pipe fitted with a roller-bridge. This makes an excellent "minor diapason bass" when derived on the pedal. Smaller scales than this merge into the violone category, so that we may assume a minimum scale of 9in. by 7in. for the CCC pipe.

The 8ft. octave (whether found in the double or in the unison stop) is frequently made of wood. Schulze was the first to show us the way. Pendlebury has introduced even further developments. The formations of these pipes are best grasped by reference to the accompanying illustrations.



WOOD DIAPASON PIPES
A. Binns, and Schulze, Armley, 32ft.
B. Schulze
C. Pendlebury

A and B are Schulze's, A being the 32ft. pipe at Armley, also adopted by Mr. Binns for his excellent 8ft. basses, B the major principal bass in the same organ. C shows the Pendlebury pipe. The latter has the upper edge of the block or languid bevelled like the metal languid, and nicked likewise, whereas Schulze's flue is un-nicked. Nicking is only required when the cap and block are not set on the same level (" flush"). Some of Schulze's basses are not provided with either beards or roller-bridges, but the latter are really necessary for prompt speech. The maximum scale for the CC pipe is $5\frac{5}{8}$in. by 5in. on the manual, 7in. by $5\frac{3}{4}$in. on the pedal. A more moderate scaling is usually more satisfactory, such as that of the Schulze major open at Hindley which is $4\frac{3}{8}$in. by $4\frac{1}{4}$in. Pendlebury's CC pipe of the major open at Leigh Wesleyan Chapel is much more rectangular in shape, being $5\frac{5}{8}$in. by $4\frac{1}{8}$in. The scale of the BB pipe of the major principal at Armley is $3\frac{3}{4}$in. by $2\frac{13}{16}$in., the diameter of the next pipe (tenor C metal) being $3\frac{1}{2}$in.; this means that the BB pipe, if of metal, would have to

be $3\frac{1}{4}$in. diameter only in order to correspond with the wood pipe scale (instead of $3\frac{5}{8}$in.): hence the wood pipe is three pipes smaller in scale than the corresponding metal one would have been.

The author has in his possession a double-languid wood diapason AA pipe made by the late Mr. A. F. Duprey for Mr. Vincent Willis. The tone is exceedingly fine and bold, and for promptitude of speech it leaves nothing to be desired. The scale is $3\frac{1}{2}$in. square. There is also a very interesting geigen 8ft. in the swell of the fine new organ by Messrs. Willis and Lewis for the Christian Science Church at Dublin. The stop consists of wooden double-languid pipes from CC to treble C, the rest being continued in metal. It is possible, in order to save expense in the 32ft. and 16ft. octaves, to adopt a similar double-note device to that mentioned under BOURDON, except that in the case of open pipes the hole is cut out at the top of the pipe and controlled by a large hinged pallet and pneumatic motor.

Double English Horn.—This was a favourite form of swell double reed with the late Robert Hope-Jones, giving a very free and fiery tone. It was practically an oboe stop fitted with open shallots (the opening being parallel). To substitute open for closed shallots to the Willis contra hautboy can hardly be called an "invention," nor is the result of such treatment highly commendable. A very free-toned double reed can only at best be serviceable as a special fancy effect, and the 16ft. orchestral oboe would seem to answer the purpose more efficiently.

Dulcet.—An octave dulciana (*q.v.*).

Dulciana.—16ft., 8ft., and 4ft. A diapason in miniature, having a small scale and small mouth-area, gently blown. Snetzler is the reputed inventor (1754). The standard scaling of this stop is 2in. at tenor C (4ft.), $1\frac{3}{16}$in. at middle C (2ft.), though a beautiful tone may be produced from a $1\frac{7}{8}$in. scale at tenor C. At CC (8ft.) the scale varies from $3\frac{1}{2}$in. to $3\frac{1}{8}$in. The mouth is usually a fifth of the circumference in width, sometimes a sixth, rarely two-ninths. Slotting makes the tone horny. The CC octave should be either bearded or rollered in order to secure prompt speech. The somewhat neutral tint of the dulciana makes it a very serviceable accompanimental stop for other solo stops. It is generally voiced on low pressure with a cut up of one-fifth of the pipe's diameter, but it can easily be voiced on any pressure up to 8in. without windiness or any other defect in the speech. In any case the actual speaking pres-

DULCIANA

sure is seldom more than 1in., often only $\frac{1}{2}$in.

The double dulciana is a beautiful stop, and most useful in soft combinations. It can also be borrowed on the pedal. The tone of the lower octaves, however, is usually more stringy than the normal dulciana of 8ft. pitch, and it is difficult to distinguish between the salicional and the dulciana when these two stops become doubles. It is possible to make the 16ft. octave of wood, using a violone scale with a low mouth lightly blown. The scale at CCC (16ft.) is 6in. if a metal or zinc pipe is used, and for the wood pipe anything between 7in. by 6in. and 6in. by $4\frac{3}{4}$in.

In the design of echo mixtures the dulciana pipe is used for the mutation ranks as being best suited for the production of subordinate tones. The octave ranks of these mixtures require different treatment. (See under HARMONICS.)

Early English Diapason.—See DIAPASON. This title was first adopted by the author to mark the successful reproduction of the old XVIIth century diapasons in his organ at St. Peter's Mission, Uxbridge. Since then, several copies have been made by English voicers.

Echo.—A prefix denoting that the stop is reproduced in miniature. This may be done by reducing the scaling and wind supply of the pipe, or else by enclosure in a swell box. The most commonly used miniatures are echo flute, echo gamba or viola, echo dulciana (a *pianissimo* diapason), echo salicional, echo trumpet or tromba, echo mixture.

Fagotto.—See BASSOON.

Fifteenth.—The superoctave diapason of 2ft. pitch (fifteen notes above the unison). As an integral part of the diapason chorus and an important member of the diapason family, the fifteenth should be treated independently of the artificial harmonic ranks and not with the idea of reproducing the natural fourth partial in the harmonic series. This subject is discussed more fully under HARMONICS.

The secret of success in voicing this rank is to treat it as a 2ft. geigen, scaling it from 1in. to $\frac{7}{8}$in. at the 1ft. C, with a fourth to two-sevenths mouth. Beyond treble C, care should be taken to avoid undue shrillness, the power of the stop reaching its maximum between tenor C and treble C. Wind pressures up to 8in. may be employed without detriment to the tone: it is merely a question of adaptation.

Flageolet.—Synonymous with Flautino *(q.v.)*. Sometimes, as in the famous Willis swell organ at St. Paul's, Knightsbridge, and at Cirencester Abbey, a fifteenth of small scale. Occasionally it occurs as a 2ft. salicet or salicetina.

Flautino.—The name flautin*a* is almost invariably used but is nevertheless incorrect, *ino* being the Italian diminutive. This is a 2ft. flute, consisting of open metal pipes of small scale,—not harmonic like the piccolo, and consequently a trifle less assertive. The mouths are usually arched, and

two-ninths or a fifth of the pipe's circumference in width. The scale at 2ft. would be about $2\frac{1}{4}$in.

Flauto Amabile.—Also called FLÛTE D'AMOUR. 8ft. and 4ft. A waldflöte in miniature. The pipes are of wood, with inverted mouths, the mouth plank being comparatively narrow. A good scale is $1\frac{5}{8}$in. by $1\frac{1}{4}$in. at middle C (2ft.). When a very soft open flute is required, it would be difficult to excel this type of flute. A very beautiful triangular specimen (of 8ft. pitch) is to be found in the swell division of the organ at St. Michael's, Berkhamstead (Foskett & Co.). A rectangular example on 5in. occurs in the swell at St. Barnabas's, Southfields (Foskett & Co.), and another on $3\frac{7}{8}$in. in the choir at All Saints', St. John's Wood.

Flauto Dolce.—See DOLCE.

Flauto Traverso.—See HARMONIC FLUTE.

Flute.—One of the four main classes of organ tone (diapason, string, flute and reed), distinguished by comparative freedom from harmonic development. There are four varieties of flute stop in the organ:—

1. Open flutes. (See CLARABELLA and WALDFLÖTE.)
2. Stopped flutes. (See STOPPED DIAPASON.)
3. Harmonic open flutes. (See HARMONIC FLUTE.)
4. Harmonic stopped flutes. (See ZAUBERFLÖTE.)

All these varieties may be made of either wood or metal.

Flûte à Cheminée.—See ROHRFLÖTE.

Flute Bass.—The 8ft. flute (usually stopped) on the pedal. It is almost invariably an octave extension of the sub-bass or bourdon, with an extra top octave to complete its compass.

Flûte d'Amour.—See FLAUTO AMABILE.

Flûte Fondementale.—See CLARABELLA.

Flûte Harmonique.—See HARMONIC FLUTE.

Flûte Ouverte.—A 4ft. open metal flute (non-harmonic), frequently found on the great of the modern Willis organ.

It is very questionable whether a 4ft. flute ought to be included in the great organ scheme, as it is so detrimental to the diapason chorus. Its sole legitimate use is in combination with the 8ft. flute, but unfortunately a great number of organists draw the octave flute with the diapasons. There is a reason for this, of course: the principal is considered too brilliant or too assertive to be "added all at once," and a softer and less obvious 4ft. tone is needed to brighten up the unison stops without overbalancing them. The reasoning is sound enough, but the flute is the wrong tone to introduce with

diapasons. What is really wanted is an *early English principal* of the Green or Snetzler type, which is absolutely devoid of brilliance yet not an actual flute. This class of tone will blend admirably with the 8ft. flute as well as with the diapasons.

French Horn.— The orchestral instrument bearing this name is hardly capable of imitation in any single stop of pipes, with its dual production of open and hand-closed tones. The closed tone, however, can be and has been very passably reproduced. Originally the attempt had been made by Mr. John Compton and others to develop horn tone from oboe pipes fitted with excessively wide bells (about 6in. diameter at the top for the 1ft. pipe). A similar specimen by Abbott & Smith occurs in the organ at St. Alban's Abbey. The great objection to the wide bell is the amount of soundboard space it occupies. The latest method is to voice an ordinary chorus reed (say $4\frac{1}{2}$in. at CC, 8ft.) on the close side on heavy pressure (from 12in. upwards), employing double length (harmonic) pipes from tenor F up, with relatively thick tongues weighted fairly high up the scale, and "filled-in" shallots. The chief difficulty associated with close reed voicing is the tendency of the reed to "choke," during which phenomenon the octave note below is heard along with the unison. This is caused by the pitch length of the vibrating tongue being too short in relation to the pressure of wind and the length of the resonating tube. By increasing the thickness of the tongue and fitting a baffle to the head of the shallot (a device introduced by Vincent Willis), this defect can be obviated.

Gamba.—See VIOLA.

Gambette.—An octave or 4ft. gamba. (See VIOLA.)

Gedackt.—Also spelt gedeckt (modern German for "covered"). (See STOPPED DIAPASON and LIEBLICH GEDACKT.)

Geigen.—See under DIAPASON. Also called geigen principal, geigen diapason and violin diapason.

Gemshorn.—8ft., 4ft. and 2ft. A metal flue stop of conical pipes, the diameter at the top being roughly a third of that at the mouth line. The spitzflöte differs in having a more graduated taper, though variations in the relative diameters at the mouth and top do not call for any differentiation in the nomenclature. Thus the gemshorn may taper to a half, third or fourth of the diameter at the mouth line according to the voicer's caprice. The *timbre* of this stop is indescribable: it is a species of horn diapason, just as the dolce with its reverse formation produces the horn flute. A very beautiful 8ft. specimen, labelled

GEMSHORN

"violin diapason," occurs in the choir at Keble College Chapel, Oxford. The 4ft. gemshorn is far the commonest, though far too little made in these days. It is not really necessary to use the actual gemshorn pipe below the 2ft. C, nor above the 6in. C. The mouth is usually two-ninths in width and kept low. There is a good example in the swell at Muswell Hill Parish Church by Harrison & Harrison, and another in the choir division of the organ at St. Elizabeth's R.C. Church, Richmond.

The bass octave of the 8ft. stop (and even the tenor octave) has been made of wood by German builders (as for instance at Armley), but there is nothing to be gained from these pyramidal pipes.

Gross Geigen.—The great double, 16ft., frequently found in organs built by Harrison & Harrison. It is of medium scale and slotted.

Harmonic.—A prefix denoting that the pipe is of double (if open) and triple (if stopped) length, and made to speak its first natural overtone instead of the prime. In flue-work the substitution of an upper partial for the prime results in pure flute tone, so that all harmonic flue stops are flutes, whether open or stopped. (See HARMONIC FLUTE and ZAUBERFLÖTE.) Harmonic reed stops may have their tubes double, triple or even quadruple length, speaking the octave, twelfth or superoctave respectively. The tone of the triple and quadruple length pipes is very pure and smooth, and very high pressures are required to secure even moderate power, and only the top octaves of a reed would be so treated. The double length tube is in very common use and enables the voicer to obtain power, clang-tint and refinement of tone as in no other way. (See TRUMPET and TROMBA for further treatment of this subject.)

Harmonic Flute.—This name is always given to double-length *open* flue pipes overblown to speak the octave or second partial, with one or more holes pierced in the centre of the pipe. *Stopped* pipes similarly treated are called zauberflöte or harmonic gedackt. The tone, which is flute *par excellence*, may be dull or bright according to the treatment of the pipe. The commercial harmonic flute is far too cloying in quality, due to the fact that the mouth is cut up too high, and often the scale is too big. It is a mistake to eliminate all the upper partials above the octave: the best tone requires the twelfth suitably encouraged by proper scaling and mouth-area. The *power* is determined by the scale of the pipe and the width of mouth employed; the *quality* by the height of mouth on a given wind pressure and the precise method of eliminating the prime. Solo harmonic flutes are usually of large scale (comparatively) and voiced on heavy pressure (anything up to 15in.), while the more delicate-toned species on the choir or echo divisions are called *flauto traverso*, and are nearly always of 4ft. pitch. The 2ft. example is generally called harmonic piccolo or (simply) piccolo. There is a medium-scaled specimen frequently assigned to the great in both 8ft. and 4ft. pitches, the late T. C. Lewis having a distinct *penchant* for the harmonic flute on this manual. The 8ft. stop, however, is hardly ever made of double-length pipes below middle F, and often the break is arranged at

C (2ft. pipe speaking 1ft. note). Below the harmonic portion, a larger scaled normal length pipe (nick-named by pipe makers a "tub") is employed with high cut and often arched mouth, the tone of the harmonic pipe being imitated as closely as possible. Very often the part which is most admired by organists is the non-harmonic register of the stop, which under skilful treatment possesses the "bloom" of the best type of wooden clarabella. There are many beautiful examples of the 8ft. harmonic flute voiced on low pressure in Lewis organs, and a perfect specimen is to be found in the Willis organ at Westminster Cathedral on the great, where the first harmonic pipe begins at treble C. The 4ft. stop is not suited to the character of this division of the organ: it does not blend with the diapasons, and in any case seems to be all the better for enclosure. (See on this question FLÛTE OUVERTE.)

Harmonic flutes are heard at their best when treated on orchestral lines. Cavaillé-Coll and Walker have both shown us how close an imitation of the orchestral flute can be obtained from organ pipes. Four examples (two by each builder) may be mentioned. St. John Baptist's Church, Holland Road, and Derby Road Chapel, Nottingham, by Cavaillé-Coll; Holy Trinity Sloane Square, and York Minster, by Walker. All of these are 8ft. stops and the Walker examples are on heavy pressure. It is possible, however to produce even more orchestral an effect by adopting a rather smaller scale, increased wind supply, low mouths with ears, a convex upper lip (not arched) and one large or several small node holes pierced at a distance of seven-sixteenths up the pipe (measured from the upper lip). The usual scale for the solo flute is $3\frac{3}{4}$in. at tenor C (normal length 4ft. pipe), and 3in. at middle C (4ft. pipe speaking 2ft. tone). Such a scale requires at least 6in. pressure. A better result is obtainable from a scale such as $1\frac{5}{8}$in. at treble C (2ft. pipe speaking 1ft. tone), which may be voiced on any pressure up to 10in. The harmonic portion may be carried down to middle C (4ft. pipe speaking 2ft. tone); but if it is desired to economise in space and expense, the break may occur at the F above. For really imitative tone, the reader is referred to the swell specimen in the organ at Burgess Hill Parish Church, Sussex; also to the 4ft. flauto traverso in the little practice organ at the Victoria College of Music, Holland Park Avenue. The former has a fourth mouth, the scale being $2\frac{3}{4}$in. at middle C (4ft.), while the latter has a fifth mouth with a scale of $1\frac{3}{16}$in. at treble E, the first harmonic pipe. Both stops are on low pressure. An instance of extreme high pressure treatment may be heard in the new organ by Messrs. Spurden Rutt & Co. at the City Temple, Holborn, where the solo flûte harmonique is voiced on 15in. wind.

The harmonic principle may also be applied to wooden pipes, though it is difficult to see any advantage in the choice of this material. The pipe may be rectangular, square or triangular in shape, with either splayed or inverted mouth. The author possesses a wooden harmonic middle C pipe fitted with Vincent Willis's double flue. The mouth is inverted, and there is the usual node hole. The scale is $1\frac{9}{16}$in. by $1\frac{3}{16}$in., the pipe being exactly $48\frac{1}{2}$in. in length from the upper lip. The *timbre* is original, being

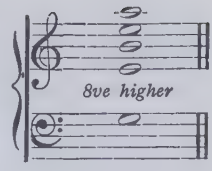
an advance even upon the orchestral instrument. As an enclosed solo stop (with or without the tremulant) this would create quite a sensation, though of course it would be rather expensive to make. The double languid metal harmonic pipe does not seem to produce a better tone than one of ordinary construction. The original flauto traverso introduced into this country by Schulze was a cylindrical wood pipe with a small square mouth, constructed in close imitation of the orchestral instrument, the pipe body being of double length and pierced with a node hole in the centre, and Roosevelt has also used a similar pipe with a circular mouth; but the trouble involved in making such pipes has deterred builders from adopting this formation.

Harmonic Gedackt.—See ZAUBERFLÖTE.

Harmonics.—Under this heading will be discussed the much-vexed question of "mixtures." Every musician knows that a musical note is in reality a chord of harmonics, the first harmonic or partial tone being the prime or fundamental (the actual pitch heard), and the other partials or overtones being variously subordinated in power according to the particular *timbre* that characterises the note. The series of harmonics runs in this order: 1, 8, 12, 15, 17, 19, ♭21, 22. Above the 22nd the harmonics become dissonant. It will be seen that the partials run closer together as they increase their distance from the prime. In fully developed string tone all these partial tones are present, in flute tone the first three only, and sometimes less than that; in clarinet tone the even-numbered partials are excluded (or at least comparatively so), and the re-arrangement and re-adjustment of the relative prominence of the different partials would seem to be the natural method of building up different tone-qualities.

The idea of artificially reproducing nature's harmonic scheme is an ancient one, but so far no striking success can be claimed in this direction. That it is possible to do so is not open to question, and the experiments which Mr. John Compton is making at the present time may at any moment lead to the solution of the problem. It has been thought that by placing each rank of pipes in the natural harmonic series from the prime upwards on a separate chest and in a separate swell box, and adjusting or silencing as required, a special harmonic apparatus could be manufactured whereby any grade of tone-colour could be evolved; but the isolation of the artificial partial tones has been proved to be fatal to that cohesion which is essential to the building up of tint. The very first requirement in an experiment of this kind is that all the ranks should share the same environment; that is to say, the whole apparatus should be either in or out of the swell chamber and regulated by other means than the closing or opening of shutters. The acceptance of this axiom is the preliminary step to success. The chief difficulty, however, that attends the artificial reproduction of *timbre* is discovered when chords are played on these synthetic tones, since it is apparent that the chances of realising dissonance instead of consonance are considerably multiplied. The single note presents little or no trouble.

A striking instance of this may be heard by playing on a pure-toned 4ft. flute (especially a harmonic flute) the following chord, which may also be repeated in diatonic progression down the scale for the distance of an octave. If played *legato* the effect is very similar to that of tubular chimes. The early English cornet was also singularly effective as a solo stop, though almost invariably a failure in chords. The twelfth or third partial tone is probably the most useful artificial harmonic of all, and may be combined with all sorts of stops with success if due care is expended on its voicing. The effect of the quintaten is also well-known in this respect. The application of this method of tone-building to the pedal basses of the organ has been referred to under ACOUSTIC BASS, and is an undoubted success. The whole subject of sound combinations is one of the profoundest problems that has ever presented itself to the student of acoustics.



It must, however, be realised that the function of creating *timbre* is not the primary nor the historic office of the organ mixture. We must trace the origin of these artificial harmonic ranks to the desire to extend the area (so to speak) of pure organ tone. Later, we find a similar desire to extend the reed chorus upwards. Mixtures are supposed not only to add brilliance but also to corroborate the unisonal or ground tone. In this dual capacity they are thought to serve as a *power-apparatus* rather than as *timbre*-creators. Now the failure in *ripieno* mixture design begins when an attempt is made to reinforce the natural overtones on the lines suggested by nature. If we make an "artistic copy" we must reduce the power of the ranks as they ascend in pitch, certain mutation ranks must be allowed to predominate over octave ranks (e.g., the 12th will be more prominent than the 15th, the 19th more prominent than the 22nd, the 17th than the 19th, the ♭21st than the 22nd), and the *timbre* of each rank, whether mutation or octave, must be pure ground tone like that of the tuning-fork. The more faithfully we reproduce the natural string model the greater muddle we make of the experiment. But as soon as we understand the true nature and office of the *ripieno* mixture we make the discovery that the importance of the octave ranks is far greater than that of the mutations. We grasp at once the meaning of octaval extension in the orchestra and organ. The desire to extend the area of tone is perfectly legitimate, both downwards and upwards. The combination of 16ft., 8ft., 4ft. and 2ft. diapasons merely represents pure organ tone *in extenso;* this is the skeleton structure of the great division. The combination of 16ft., 8ft., 4ft. and 2ft. chorus reed tone creates a complete reed chorus, the 2ft. "reed" being in reality a flue stop. Viewing the subject from another angle we may call it the process of doubling and trebling the unison, and this quite apart from the actual method of obtaining the desired effect, whether by octave coupling or by the provision of independent ranks of pipes. The fact that the octave and superoctave take their place in the natural harmonic series (i.e., the second and fourth partials) has been apt to engender confusion of ideas in the design and treatment of mixtures, as if it were the motive which underlay their introduction to the

tonal scheme of the organ; the real motive is that which inspires the composer to write double octave passages for the pianoforte or the orchestra, or double his parts for a vocal chorus.

Let us see then whether any rules can be formulated for the artistic treatment of the octave ranks of the diapason chorus, for it is in this tonal department of the organ that the greatest difficulty is experienced. The series consists of the suboctave, unison, octave and superoctave, that is, 16ft., 8ft., 4ft. and 2ft. ranks. The main objective is *cohesion*, which is the sole criterion of success. As, however, we want a cohesion of beautiful tone, there must of necessity be a limit to the sacrifice of individual beauty to the *ensemble*. That certain qualities have to be sacrificed to the good of the whole is a truth yet to be grasped by organ builders: undue prominence, whether of foundation or of brilliance, in any single rank of the series, anything, in short, that violates the law of proportion must be wrong. Selfishness is ever the enemy of harmony. Each rank must be prepared to contribute something to the others. From this we are able to deduce two fundamental principles of octaval extension in series. The first is that the *timbre* of each rank must be similar in type; the second is that the *timbre* selected must be the aggregate *timbre* of the whole. A diapason chorus, therefore, should consist of four ranks of diapason octaves which, sounded together, express diapason tone. We should expect an analogous result from a reed, string or flute chorus. When, however, we descend from the philosophy of the subject to practical details, difficulties at once confront us. At the extreme ends of our diapason chorus, for instance, we find a double and a fifteenth; both are diapasons, yet they have little in common when viewed together. There is only one *modus operandi*, and that is to start at the bottom and build up the edifice in true masonic style. The foundations of the New York skyscraper lie very deep below the earth's surface: the higher the building the deeper the foundation. A good, solid subunisonal foundation being laid, we have at least made a hopeful start along the road to success. But in doing this it is necessary to bear in mind the rank that comes next in the series. What mortar is to the bricks of a house, the natural overtones are to the prime. Without a certain degree of harmonic development each rank in the series becomes isolated from its neighbour, the links in the chain are separated. True diapason tone possesses a modicum of overtones (see under DIAPASON), which is sufficient for the purpose. At Armley, Schulze has shown us the model double or 16ft. rank. It is massive, yet its massiveness does not interfere with its capacity to blend and bind. Willis has given us another example at Westminster Cathedral. Next comes the unison. The theory is propounded by some that this important rank should aspire to no position of prominence above the rest of the series. Schulze certainly acted on this principle at Doncaster and Armley, but appears to have abandoned it later, notably at Tyne Dock and at Hindley. It is not so much a question of preponderance as of balance. If the unison does not subvert the structural balance and symmetry of the chorus, there can be no possible objection to assigning to it a certain degree of prominence in relation to the whole. The final arbiter is the ear, and the ear

alone can decide such a point. It is perhaps a more reasonable theory that assigns to the rank that represents the standard pitch of the chorus certain privileges not accorded to the other members of the family. The unison, however, should be treated with some regard for the octave rank that follows. The "cement" must be provided here also. The combination of two octave ranks should result in strengthening the lower rank and making provision for the next octave rank above. The overtones of each rank should be lost in the fusion. Only the presence of those of the top rank should be noticeable as each rank is added, until with the crowning of the edifice with the superoctave all discernible overtones in the individual members of the chorus are submerged. With this ideal in mind, the practical treatment of the octave and superoctave is not a serious problem. While a uniformly broad treatment is legitimate in the case of the unison, the treble register being assigned a more graduated scale during the ascent, the octave and superoctave require the reverse treatment, the scale ratio diminishing more rapidly in the ascent in order to guarantee that sufficiency of harmonic development familiarly known as "sparkle." Above the 3in. C, the superoctave should be allowed a gradual diminution of power, but not of sparkle; its power should be greatest from the 6in. C to the 3in. C. The point of culmination is best shown thus :—

CC (2ft.) Ten. C. (1ft.) Mid. C (6in.) Treb. C (3in.) Top C

From the foregoing observations we may formulate the following rules in the treatment of the individual ranks of the diapason series :—

1. Each rank must belong to the tonal category that distinguishes the family from other categories.

2. At the outset the designer must select the *timbre* that he wishes to predominate in the whole, and no rank must be allowed to assert an antagonistic personality.

3. Each individual rank must possess its own degree of harmonic development, by which alone cohesion can be secured between the members.

4. The power of each rank must be adjusted with due regard to the laws of proportion and balance.

5. The predominance of the unison is legitimate provided the balance of the structure is not thereby upset.

6. The scale-ratio of each rank is determined by the relative position that rank occupies in the series; the diminution during ascent increases in rapidity with each higher octave rank.

7. All ranks forming the chorus must share the same atmosphere and environment.

The question must now be discussed as to how far we are justified in using mutations with octave work. We have already conceded the value

and utility of mutations in the formation of an artificial *timbre*-creating apparatus. Creating brilliance and power is another problem altogether. Do mutations help to solve it? It is claimed by some that mutations perform a dual office: they bind the octave ranks together, and they create a resultant, thus reinforcing the unison. We have seen that the first of these functions is admirably performed by the octave ranks themselves by means of their own intrinsic harmonic development, and it is also a fact that the suboctave and octave corroborate to a degree the central unison rank. Directly mutations are added the trouble begins, for the purity of the chorus, already a homogeneous whole, is invaded by a foreign element, which has to be grafted into the body. It is this process of assimilation that bids defiance to the designer. The truth is borne in upon us that the mutation is not a diapason, but that, like the flute, string and reed, it belongs to a different tonal category and must be treated as such. Well, just as we add our full swells and our reed choruses to the diapason structure, grafting on to the pure organ tone a *fresh* mosaic of colours, so it should be possible to make artistic use of mutation work. But this is rather the creation of a passion-*timbre* than the addition of power and brilliance *per se*. And it is difficult to dissociate mutations from chorus reeds in the production of a passion-*timbre*, where power is required. Now reeds are capable of intense harmonic development, especially up to the 2ft. C. We know also that all musical instruments possess this capacity in the lower register. Hence it might be reasonably inferred that artificial harmonic assistance is superfluous in this part of the manual compass, except possibly in the case of the sub-mutation, which creates a resultant and performs an entirely different function. In the upper portion of the compass, however, nature ordains that the overtones should gradually diminish during the ascent, until it is almost impossible to tell to what category the tone of the various stops belongs. Art demands purity in these octaves, and any attempt to force unwilling harmonics out of these smaller pipes only results in dissonance and screaminess. Were the use of these stops confined to the performance of solo effects, the reduction of power in the treble would not matter, indeed it would constitute a virtue; but in the playing of chords, especially massive chords, the treble part is apt to be drowned if not reinforced in some way. A superoctave rank is a great help in addition to the 4ft. chorus reed, but if made too brilliant it stands away from the reed chorus, while if softened the effect may be lost. The insertion of mutations at this point would seem to solve the difficulty, though it has yet to be proved that the complete series is required. We have, however, arrived at this conclusion, that in cases where the bass, tenor and middle octaves of the manual compass are provided with pipes yielding ample harmonic development, artificial corroboration is needed at some point to continue this degree of development uniformly through the treble octaves. From this we also infer that high-pitched ranks of pipes are superfluous in the lower half of the compass, and that for the creation of brilliance nothing above the superoctave is ever necessary in the modern organ.

The most important of all the mutations is the fifth-sounding rank, and it is the most tractable and therefore the most popular. The quint ($5\frac{1}{3}$ft.),

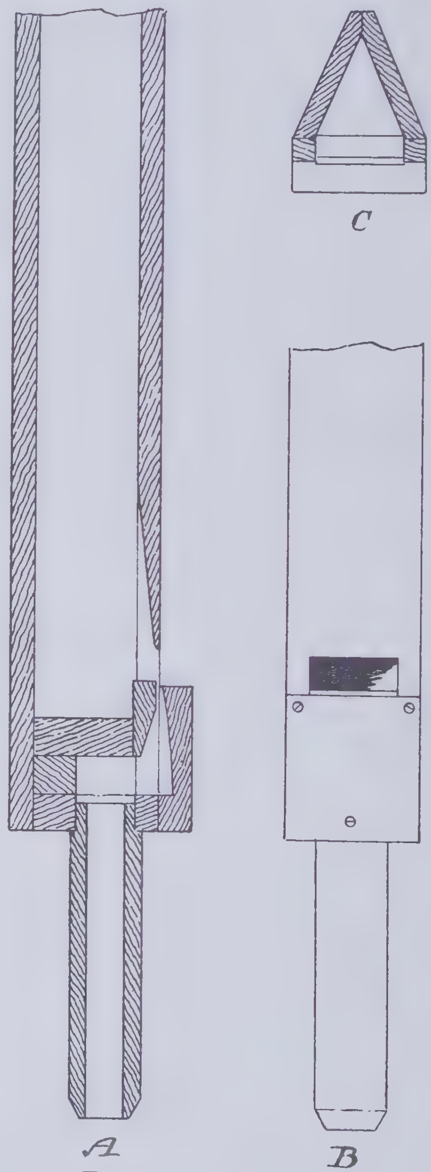
really a sub-mutation, is valued for its corroborative influence on the 16ft. and 8ft. stops, since it creates a resultant in combination with the unison (see ACOUSTIC BASS). The twelfth ($2\frac{2}{3}$ft.) is supposed, in combination with the octave, to strengthen the unison in the same way, but this corroboration is by no means patent. It none the less contributes its quota to the power and brilliance of the upper half of the manual compass, and provided it is sufficiently covered by the superoctave is capable of artistic use. Modern consensus of opinion is in favour of the fifth-sounding ranks being voiced on the fluty side, the quint being a stopped pipe and the twelfth an open flute or an early English diapason of the cornet type.

The tierce (tenth, $3\frac{1}{5}$ft.) and the septime (flat fourteenth, $2\frac{1}{7}$ft.) are dangerous ranks to introduce in any part of the compass, and should at least be treated on dulciana lines, the septime being a mere breath of tone. Their presence in a *ripieno* mixture scheme is a very doubtful advantage, even when regarded as harmonics of the 16ft. rank, and the question as to whether these mutations should not be relegated to the orchestral and echo divisions of the organ is well worth the serious consideration of tonal architects. On the pedal, however, where the advantage of resultant tones is apparent, a definite value can be set to mutation work; for it may be used for the purpose of reinforcing the harmonic series of the 32ft. violone, as explained under ACOUSTIC BASS. Moreover, as it is possible to borrow the ranks from various manual stops, and the compass is strictly limited, the effect obtainable is fully commensurate with the cost. In this department, too, the mutation serves both as a *timbre*-creator and as a harmonic-corroborator.

In conclusion, we may sum up the main points of this discussion as follows: The natural harmonics of musical tone are artificially reproduced in the organ with the two-fold object of creating *timbre* and of imparting power, corroboration and brilliance in those portions of the gamut where these qualities are required. The synthetic treatment of mixtures in the production of various tone-colours is still in its infancy, yet promises to fulfil great results in the future. The justification of such experiments when crowned with the success they deserve will lie in the provision of a tint-apparatus that will keep in tune with the rest of the flue-work of the organ through all hygrometric changes. For the creation of brilliance and power the doubling and trebling of the unison known to organ designers as octave extension is a principle of the highest importance, the introduction of mutation ranks being regarded as of value only in maintaining the proper balance of tone uniformly throughout the compass. Since the lower octaves are well supplied with harmonics by natural endowment, it would seem unnecessary to carry the artificial corroboration below a certain point, and consequently mutations are only required for the upper half of the compass, and even in this register are to be "applied with caution," while in the lower register nothing higher-pitched than the superoctave or fifteenth would seem to be of any practical utility. The elimination of all ranks above the superoctave, moreover, automatically solves the difficult problem of the "break," since the *ripieno* mixture can be formed of ranks capable of running to the top note of

the keyboard without interruption. One may observe, too, that a few harmonic ranks artistically treated, adequately supplied with wind, with separate drawstop control, and kept regularly in tune, are a thousand times more effective in an organ tonal scheme than double the number of ranks huddled together on a single soundboard slide in accordance with past and present practice. It is not too much to say that the study of artificial harmonics after many centuries has progressed but a small distance, that we can count on the fingers of one hand the names of those who have offered any material contribution to the subject, the great majority having pursued the sordid paths of commercialism, and that it is only by a fresh beginning that any real achievement can be attained in the organ of the future.

Hohlflöte. — Under this name many species of open flute of wood or metal may be grouped, if we are to be guided by the examples of organ builders. As, however, the hohlflöte is a stop of German origin, it will suffice to mention two distinctive types introduced into this country by Schulze. The first is a quadrangular wooden diapason pipe with a plain, straight cap and sloping block similar to those used by Schulze for the diapason basses at Armley. (See DOUBLE DIAPASON.) The flute tone is produced merely by cutting up the mouth of this pipe, in the same way as the conversion of a metal diapason pipe into a flute would be effected. The original example was rectangular in shape, with the mouth formed on the wide plank, and was placed in the 1851 Exhibition organ. At St. Mary's, Tyne Dock, a square pipe was used;



TRIANGULAR HOHLFLÖTE
(with inverted mouth)

and excellent copies of this latter example are to be found in the organs at Keble College, Oxford, and St. Matthew's, Willesden, by Mr. H. S. Vincent.

The second type of hohlflöte is a triangular wood pipe similarly treated, examples of which are to be found in the Schulze organs at Doncaster, Armley and Hindley, and in a number of English organs since built. In both types it will be observed that the area of the mouth is large in proportion to the transverse area of the pipe, and it is for this reason that this particular formation of pipe was chosen. Modern practice prefers an inverted upper lip and sunk block with a notched cap. Examples of hohlflötes constructed of rectangular wood pipes with inverted mouths on the wide side occur in the organs at the Battersea Polytechnic Institute and at Holy Trinity, Upper Tooting (both voiced by Whiteley), and also in many of Mr. Binns's instruments. The 4ft. triangular inverted mouth flute is often found in the great division of Messrs. Harrison & Harrison. (See also under Clarabella, and under Hollow Tone in the *Glossary*.)

Horn.— See French Horn, Cornopean. The horn of the old builders was more an attempted imitation of the hunting horn (waldhorn) than of the orchestral instrument, the former possessing a much freer quality of tone. It was apparently thought by those builders that a trumpet pipe with the tube made to a larger scale than usual would create the requisite smoothness; whereas we now know that the open shallots, wide tips and low pressures then in vogue effectually defeated the end that was in view. The fat and rasping tone of the hunting horn, admirable as it may be for the purposes of the chase, is hardly deserving of reproduction in the organ; but that of the orchestral horn, especially the closed *timbre*, amply repays the heroic attempts that have been made by voicers and which have been rewarded with some measure of success. The beating reed would seem to be the best medium for this purpose, despite the "horny" *timbre* of the inverted mouth wooden flute. (For further particulars on this subject, see French Horn.)

Horn Diapason.—A slotted diapason. The quality of "horniness" which is so frequently applied to organ flue stops is extremely difficult to describe in words, though readily enough detected by the cultivated ear. It is supposed to be caused in flue pipes by the process of "slotting," or else by the adoption of an inverted conical pipe body in place of the usual cylindrical shape, or again by the addition of an inverted conical bell or funnel to the cylindrical pipe body. The influence of the slot upon the tone of a flue pipe is a subject of great interest. The slot is a narrow, vertical, oblong hole cut out of the pipe at a distance of the pipe's diameter from the top of the pipe, and may vary in width from a third to a fifth of the pipe's diameter. So far as it is possible to analyse the harmonic overtones of organ pipes, it would appear that this particular device favours the fifth, sixth and seventh partials,—i.e., the 17th, 19th and ? 21st, the 17th being more in evidence when the slot is narrow. The reinforcement of this group of harmonics at some distance from the prime naturally exercises a peculiar influence on the *timbre*

of the pipe thus treated, the result being the *grafting* of string tone on to the fundamental rather than a natural harmonic development of it. This curious semi-isolation of the prime from the overtones thus explained is a notable feature of the slotted diapason, the tone of which is somewhat reminiscent of a ball of fluff with spikes sticking out of it. To modern ears, the quality of tone imparted by the slot to large or moderate-scaled diapason pipes is objectionable on account of its hybrid nasality. With the diminution of scaling, however, the apparent hiatus between prime and overtones is effectually bridged by the reinforcement of the lower partials (i.e., the octave, twelfth and superoctave), so that the slotting of viols has no deleterious effect upon the string *timbre*. The safety line may be drawn at the 2in. tenor C (4ft.) scale: from this point an increase in scale seems to produce horniness from the slotted pipe. The keraulophon of the Victorian era was in reality a diminutive horn diapason, though a small circular hole was originally substituted for the slot; and Thynne's swell echo salicional comes under the same category, the scale of both these stops being $2\frac{1}{4}$in. or $2\frac{3}{8}$in. at tenor C (4ft.), with a fifth mouth. Happily, the idea of slotting diapasons, especially the diapasons of the great organ, has already fallen into desuetude.

The practice of slotting diapasons for tuning purposes is rather a dangerous one, in spite of the fact that the slot is cut quite close to the top of the pipe and is also as wide as possible (usually two-thirds the diameter). Those who adopt this device object to the ordinary tuning slide being sprung on to the top of the pipe as liable to derangement through the tuner reaching over the tops of one set of pipes to obtain access to another set beyond: the slide being fitted below the top of the pipe and round the slot effectually precludes this risk. On the other hand, the operation of tapping down the slide to sharpen the pipe in the latter case is more trying; and also there is the possibility of the tuner leaving a small portion of the slot uncovered below the slide, so that the *pros* and *cons* are equally balanced. Such slotting can hardly be said to exercise any influence on the tone of the larger pipes, say below middle C; but above this note it is best eschewed altogether, because there is the danger that certain individual pipes may be affected adversely and prevent a really artistic regulation of the series.

Keraulophon.—See the concluding paragraph under HORN DIAPASON above. The real article is not now made, the effect being produced by slotting a dulciana or a salicional pipe.

Lieblich Bordun.—A 16ft. lieblich gedackt *(q.v.)*.

Lieblich Flöte.—A 4ft. lieblich gedackt *(q.v.)*.

Lieblich Gedackt.—See STOPPED DIAPASON, ROHRFLÖTE. Ged*e*ckt is the modern German spelling, and means "covered." Introduced by Schulze in his 1851 Exhibition organ, where it attracted considerable attention at the time, thus proving the difference that subsists between the tone quality of this stop and that of the early type of wooden stopped diapason.

Although the lieblich gedackt can be made of either wood or metal, the distinctive *timbre* is always associated with the small scaled metal pipe. The Schulze pipe was stopped with plain corks, unperforated, of course, and the upper lips were unflatted and arched. Exact reproductions of the Schulze stops may be heard in the organs at the Victoria College of Music, Holland Park, and at the Willesden Green Baptist Church (Foskett), the scale being $1\frac{1}{8}$in. at middle C (2ft. tone). Mr. Binns has also faithfully reproduced the original in a large number of his organs. Later, we find Willis substituting for the plain cork of Schulze the pierced wooden stoppers (lined with cork or leather) since adopted by nearly all present-day builders. Sliding "canister" tops are occasionally used in place of stoppers, but the scale of pipe is generally somewhat larger than the lieblich, and the tone is that of a cor de nuit or rohrflöte *(q.v.)*. The 8ft. and 16ft. bass of the lieblich is almost invariably made of wood, though a few instances of metal and zinc basses with canister tops are to be found. The usual scale of the wood bass at CC 8ft. is $3\frac{1}{8}$in. by $2\frac{1}{8}$in., the mouth being cut up to the same height as its width or sometimes even more, and never less than three-quarters its width. The 16ft. stop is usually called lieblich bordun, and makes a useful double in the echo division. The lowest octave, however, should receive more generous scaling than would be derived from the normal ratio, nothing less than $5\frac{1}{2}$in. by $4\frac{1}{2}$in. at CCC, otherwise enclosure will tend to annihilate the fundamental. The 4ft. specimen is called lieblich flöte, and is a very charming stop when well voiced. It sounds at its best on an open soundboard, or else in a swell box formed of inch panelling. The late T. C. Lewis was very fond of grouping a complete family of lieblichs, from 16ft. up to 2ft., on his unenclosed choir organs (as, for instance, at St. Peter's, Eaton Square). The lieblich pipe also forms an excellent quint, while a twelfth composed of these pipes occurs in the organ in New College Chapel, Hampstead, on the great.

LIEBLICH GEDACKT

Major Bass.—The principal 16ft. open diapason stop on the pedal. (See DOUBLE DIAPASON).

Mixture.—See HARMONICS.

Musette.—The instrument was a small bagpipe used by the ancients, and belongs to the chalumeau *genus*. It is a free reed stop in French organs, but in this country it is to all intents and purposes a diminutive scaled clarinet, with an orchestral oboe shallot. (See ORCHESTRAL OBOE.) The tube is cylindrical, like the clarinet tube; but whereas the scale of the latter at the 2ft. C (the tube being 1ft. $1\frac{1}{2}$in. long) is 1in. to $1\frac{1}{8}$in., the scale of the

musette for this pipe would not be more than ¾in., the length of the tube being slightly less (about 1 ft.). Mr. Compton has used this type with a cap at the top and a small hole pierced in the tube at a distance of about a third of the pipe length from the top. A more quaint and pastoral *timbre* is secured by using a clarinet shallot, the apex of the V-shaped opening being cut at a distance of a fourth from the head or base, while the narrow orchestral oboe shallot with its saw-cut opening makes the tone thinner and freer. The stop properly belongs to the solo and orchestral divisions, and is best employed in 8ft. pitch.

Mutation. — An artificial harmonic rank of flue pipes which does not sound the unison or any of its octaves. Such ranks are the quint, tierce and septime,—that is, the fifth, third and seventh, sounding partial tones and their octaves. Thus all the harmonics or concordant partials of the prime note, when artificially reproduced in the organ, are classified into two main divisions,—the octaves and the mutations. (See HARMONICS.)

Muted Viol (also called Viole Sourdine). — An attempt to reproduce muted string tone, though hardly successful as such. Nevertheless, as so often happens, the experiment (made by William Thynne and developed by John W. Whiteley) led to the addition of a fresh tone colour to the organist's palette of great value in the echo division of the organ. The Thynne stop (first introduced in the famous Tewkesbury Abbey organ on the unenclosed choir) was a moderately small scaled viol 1¾in. at the 4ft. pipe, slotted and rollered, with a fifth mouth and small foot hole. In short, a viol voiced on dulciana lines. The Whiteley specimen, introduced in the Hope-Jones instruments, is a very small-scaled tapering pipe of the gemshorn order, with a sixth mouth and rollered. The voicing is the same as that of the viole d'orchestre (*q.v.*). Although Whiteley's scale was as tiny as 1¼in. at the mouth line and ⅝in. at the top for the 8ft. pipe, it is better, from a practical point of view, to adopt a larger scale, such as 2in. at the mouth and 1in. at the top at CC (8ft.). The *timbre* of these stops is that of an echo viole d'orchestre. A very ethereal céleste can be formed from the combination of two muted viols, the one tuned slightly flat to the other. Only spotted metal or tin should be used for these delicately voiced pipes.

MUTED VIOL

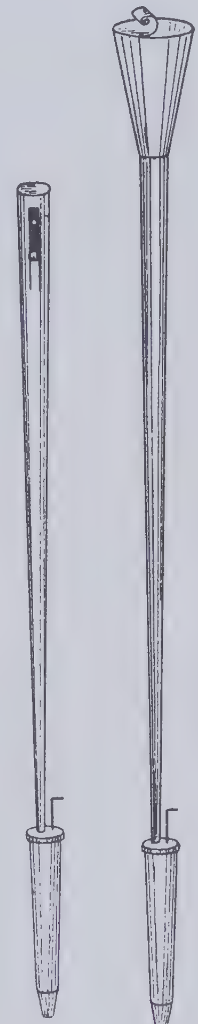
Nason Flute (or simply "Nason").—A 4ft. stopped wooden flute, with the ordinary splayed mouth very low cut, frequently used by the old builders. In the modern organ there is room for this charming little stop on the un-

enclosed choir (chayre) division, which should reproduce as far as possible the old fashioned cathedral great organ of the XVIIth century. The complete scheme for Westminster Cathedral includes this section, where the nason finds a place. A nason (labelled "flute 4ft.") forms an interesting feature of the great at St. Barnabas's, Southfields, which also contains an early English diapason (labelled "small open diapason"). A good scale is $1\frac{1}{8}$in. by $\frac{7}{8}$in. for the stopped 1ft. pipe giving 2ft. tone. The 4ft. metal rohrflöte or chimney flute also makes a charming nason.

Nineteenth (also called Larigot). — A mutation rank speaking the nineteenth note above the unison, that is the octave twelfth, and designated $1\frac{1}{3}$ft. It represents the sixth partial tone in the natural harmonic series. (See QUINT, TWELFTH, HARMONICS.)

Oboe (also spelt Hautboy). — 16ft. and 8ft. Although named after the orchestral instrument, the organ stop when called simply "oboe" is not imitative but is either a miniature trumpet or else a miniature horn. When the orchestral tone is reproduced, the stop is called "orchestral oboe."

The ordinary unimitative oboe (invariably included in the swell division of the orthodox organ) is a reed pipe, the tube being of inverted conical shape, slender in scale and surmounted by an inverted conical bell. One may compare with this the conical and belled tube of the orchestral instrument. The length of the tube is practically the same as that of the trumpet, the smaller scaling of the oboe reducing the length a trifle. The bells are usually fitted with half caps or shades of metal, soldered on to the top, for regulation of the tone and power. Sometimes the cap is completely soldered on all round, and a slot cut out of the bell just below with a regulating tongue. The length of the bell at the 4ft. pipe is about a fourth of the length of the tube (*minus* the bell); but as the pipes get smaller the bells become relatively longer, until in the top octave their respective lengths are actually reversed The diameter of the tube at the point where the bell is soldered on is about one half to a third of that of the top of the bell. It is a mistake to discontinue the reed pipe at top D or thereabouts and complete to the top note with flue pipes. The oboe pipe, with or without the bell, should be carried up as far as the top F (the fifty-fourth note from CC). The scale at the



ORCHESTRAL OBOE   OBOE

top of the bell at the 4ft. pipe is usually $2\frac{1}{2}$in. to $2\frac{3}{4}$in. The lowest octave (CC to BB) is generally made of bassoon pipes (see BASSOON), but many examples of a real oboe bass with bells are still to be found, the scale being 4in. at CC (8ft.). The contra hautboy 16ft. of Father Willis consisted of real oboe pipes right down to the 16ft. note, the scale at CCC being 6in. This beautiful double reed is the last word in soft, smooth, reed tone, and is really an echo double horn. The lowest twenty-four pipes have their tongues loaded at the end with the characteristic Willis brass weights. The oboe shallot is of medium scale, with a V-shaped opening extending the distance of a third to one half of the shallot's length from the head or base. The tongues are finely curved, the distribution of curvature being more gradual from the position of the tuning spring to the end of the tongue than in the case of the trumpet or chorus reed. The curve naturally increases with the increase of wind pressure, though oboes are not dependent on high pressure for good tone. The production of the two types of oboe—the trumpet and the horn respectively—is in the last resort determined by the manipulation of the adjustable cap at the top of the bell (or of the slot tongue if the bell is fully capped). When trumpet tone is required, the caps are opened up, thus shortening the tube, and the tuning length of the tongue adjusted (lengthened) accordingly. This process gives a louder and thinner tone, and is especially effective in the upper half of the manual compass; but care must be taken with the regulation of the tenor and middle octaves, which should become gradually smoother during the descent to tenor C. There is, however, a very important point in connection with this type of oboe which distinguishes it from the horn type, and that is the diameter of the head of the tube in relation to that of the bell top, or (to put it another way) the precise formation of the bell. In the trumpet type, the scale of the tube and of the bottom end of the bell is approximately half the scale of the bell top, and this makes the conical formation of the bell less pronounced. The other type of oboe has a narrower tube-head, the scale of this part being a third of that of the bell-top: the wider cone surmounting a narrower tube (the diameter of the bell-top being the same in both types) assists in the production of horn tone. It is possible to effect a real tonal contrast between the two kinds of oboe by making the shallot opening in the one instance one-half the shallot length, and in the other instance (for horn tone) only a third or even a fourth. The latter type is, of course, rather softer than the trumpet oboe, since the caps are kept more closed and the tuning length of the tongue relatively shortened. A larger scaled edition of this stop was introduced by Hope-Jones under the name of "oboe horn." There are really beautiful examples of the trumpet oboe in the organs at All Saints', St. John's Wood, and at St. Barnabas's, Southfields, both on 5in. wind. The subjoined table of measurements relating to the former specimen may be of service to the student. The almost violin-like *timbre* of this stop when played in solo passages with the tremulant places it very high in the list of tone creations. In the choir division of the organ at St. Elizabeth's R.C Church, Richmond, the echo tromba is in reality a trumpet oboe.

PIPE	DIAM. OF BELL	DIAM. OF TUBE	LENGTH OF BELL	LENGTH OF TUBE
Ten. C	$2\frac{5}{8}$ in.	$1\frac{1}{4}$ in.	9 in.	30 in.
Mid. C	2 in.	1 in.	$5\frac{1}{2}$ in.	$13\frac{1}{4}$ in.
Treb. C	$1\frac{3}{4}$ in.	$\frac{13}{16}$ in.	$2\frac{15}{16}$ in.	$5\frac{1}{2}$ in.
C in alt.	$1\frac{3}{16}$ in.	$\frac{9}{16}$ in.	$2\frac{1}{4}$ in.	$1\frac{1}{2}$ in.

MIDDLE C SHALLOT MEASUREMENTS

Length 2 in.	Outside diameter of head $\frac{3}{8}$ in.	Length of opening $\frac{15}{16}$ in.
	Inside diameter of tip $\frac{1}{4}$ in.	Width of opening at base $\frac{1}{8}$ in.

The orchestral oboe is primarily a solo stop, and treated with the object of obtaining the thin, acid-sweet *timbre* of its prototype. There are three known methods employed in the construction of the tube. One method is to utilise the normal oboe tube and bell, and considerably reduce the scale of both. The shallot is likewise reduced in scale, with a mere saw-cut opening, the base being sloped backward as indicated by the dotted line in the illustration of the beating reed on page 66. This form of shallot can be used in all three types here described, and is known as the orchestral oboe shallot. The first type, however, is employed by Willis for the cor anglais. The scaling of the Walker orchestral oboe (which is made according to this pattern) is as follows: CC (8ft.), $2\frac{9}{16}$ in. at the top of the bell, $1\frac{1}{16}$ in. at the bottom; tenor C (4ft.), $1\frac{15}{16}$ in. at the top of the bell, $\frac{3}{4}$ in. at the bottom. The bells are half-capped, and have a small hole pierced about midway between the top and the bottom of the bell.

Another method is that introduced by Willis many years ago. The tube is that of a small scaled bassoon (inverted conical, without a bell), covered at the top by a cap soldered on all round (known as a "complete cap"), a slot being cut below. The tone is less thin and piquant than that of the first type: the scale at CC is 2in.

The third variety is that advocated by the late Mr. J. M. Boustead, who adopted it, as the result of many experiments, in his large chamber organ at Westfield, Wimbledon Common, now removed and used up as material for two separate organs. Mr. Boustead took an ordinary oboe pipe and cut the tube down to a third its length, making the middle C (2ft.) pipe about 8in. long and the tenor C (4ft.) pipe about 1ft. 4in. long. The diameter of the tenor C pipe thus cut down would be about $\frac{5}{8}$ in. Above treble C (1ft.), the third length becomes too short for practical purposes and the pipes have to be made harmonic,—that is, two-thirds the normal oboe length. Adjustable caps are, of course, necessary for regulation. Now, it is interesting to note that the third length tube is normally the resonating length of the twentieth semitone above any given unison,—that is to say, the length of the twelfth or third partial. It would appear, therefore, that this particular type of tube emphasizes the twelfth along with the ground tone, and that the two-thirds tube in the harmonic portion of the stop emphasizes the fifth above the prime. In order to reproduce the "woody" *timbre* that characterises the

orchestral instrument, it is best to eschew the very narrow shallot with its saw-cut opening (a diminutive open reed) and use a V-shaped oboe shallot of somewhat reduced scale. Since, however, the most successful results are obtained from thick tongues and high wind pressure, the shallot should be rather longer than the normal oboe type, so that the tuning spring may be drawn further back, about a distance of two-thirds of the shallot's length from the head or base, at which point the note should be in tune. The curvature of the tongue is that of the unimitative oboe or the clarinet, finely distributed along the vibrating length. For the CC to BB octave, the Willis (second type) tube is generally used, and there is no need to adopt any other form of construction.

Oboe Horn (16ft. and 8ft.).—The name given by Robert Hope-Jones to a large-scaled unimitative oboe, voiced to produce a close tone. An example may be heard at Llandaff Cathedral. The title, however, would better fit the smooth toned oboe referred to under OBOE *(q.v.)*, thus distinguishing the type from the more free-toned variety. Examples of the 16ft. double oboe horn may be found in the organs at Great Gaddesden Church and All Saints', St. John's Wood, where the stop forms the double reed on the great.

Octave.—The first upper partial (or second harmonic) of a musical note, the first harmonic being the prime or ground tone. When prefixed to the name of an organ stop, the word "octave" denotes that the pitch of the stop is an octave higher,—that is, 4ft. on the manuals and 8ft. on the pedal. The octave diapason or principal is sometimes called "octave 4ft."

Octave Quint.—The twelfth is sometimes so named,—e.g., in Harrison organs.

Open Diapason.—See DIAPASON.

Ophicleide.—The name given by the firm of Willis to their pedal 16ft. chorus reed or trombone. The ophicleide scale varies from 6in. to 8in. at CCC (16ft.), and the shallot for this note is of the closed type, the scale at the head being $1\frac{1}{16}$in. and the length of the shallot about 6in. (See TROMBONE.)

Orchestral.—This prefix denotes that the stop belongs to the category of imitative organ tone,—e.g., orchestral flute, orchestral oboe, orchestral viola, &c.

Phoneuma.—See ZARTFLÖTE.

Piccolo.—A superoctave or 2ft. flute, distinguished from the flautino and the flageolet by being made of double length or harmonic pipes blown to speak the octave or first upper partial. The piccolo (also called "harmonic piccolo") is actually a 2ft. flauto traverso (see HARMONIC FLUTE), and is very popular as a choir stop, as it effectually crowns the softer enclosed flute family. In some of the choir organs of the late T. C. Lewis, the 2ft. lieblich gedackt was labelled "piccolo." Unfortunately, the 2ft. *flute* is not the best of tone builders, it being only successful in combination with

the other flutes of its division, hence the salicetina or echo fifteenth is taking its place in the modern echo and choir divisions as being more generally suitable. The idea of making the piccolo the only 2ft. stop on the great in place of the superoctave diapason or fifteenth is happily losing ground, though not even yet quite defunct.

Posaune.—A trumpet or tromba of powerful tone. The name hardly deserves perpetuating, as it does not stand for any particular type of chorus reed tone. Father Willis frequently labelled his swell double reed "contra posaune."

Principal.—The octave diapason. In German organ stop nomenclature "principal" is the name for the diapason. In England the 4ft. diapason (on the manual) is called "principal" because it forms the basis of tuning, "bearings" being laid on its middle octave as a preliminary step to the general tuning of the organ.

The voicing and treatment of the principal or octave diapason is discussed under HARMONICS.

Quint.—A mutation rank sounding the fifth note above the unison. More correctly, it is a sub-mutation, as the first fifth-sounding partial above the prime is the twelfth or octave quint; but the quint may be introduced as the twelfth to the subunison or double, both on the manual and on the pedal. It is labelled $5\frac{1}{3}$ft. and $10\frac{2}{3}$ft. accordingly.

The chief value of this rank consists in the production of resultant tones. (See ACOUSTIC BASS.) It is specified on the manual with the object of reinforcing the double, and when the latter is a stop of free harmonic intonation such as the contra viola, considerable weight is added to the *ensemble*, as is well illustrated at St. Peter's, Hindley, where the great organ quint combined with the contra viola da gamba and major open diapason gives the effect of an added bourdon. This manual also contains a bourdon as well as a contra viola, so that the aggregate effect of all four stops is exceedingly dignified. The quint is usually (and rightly) made of stopped pipes of metal or wood, the scale being moderate and the tone soft and foundational. The pedal quint is employed to create in combination with the 16ft. pipe a 32ft. resultant effect, but this subject will be found more fully explained under ACOUSTIC BASS.

Quintaten (also spelt Quintatön, which is hardly correct in view of the derivation of the word from the Latin *quintam tenens*, which means "holding the quint").—This is a stopped pipe speaking the prime and the twelfth simultaneously. Every organist is familiar (alas!) with the "coughing" bourdon that speaks the twelfth first before settling down to its fundamental note. This means that the mouth of the pipe is too low in proportion to the supply of wind admitted to the foot, thus causing the pipe to overblow to its first upper partial. Were the wind supply greater still, the pipe would probably continue to overblow and speak the twelfth *instead of* the prime tone. (See ZAUBERFLÖTE.) If, however, a bridge or roller is

placed in front of the mouth between the ears (assuming the correct position), the prime note will return and be accompanied by the twelfth. The pipe, in short, becomes a quintaten.

The tendency of the twelfth to predominate over the prime makes voicing more difficult than would at first sight appear, for the prime should if anything be somewhat more prominent. Metal pipes are best for this class of work, with a mouth not more than two-ninths in width, cut up a fourth of its width and bearded or rollered. A good scale is $1\frac{5}{16}$in. at middle C (2ft. tone). Wood is generally used in the bass octave.

The 16ft. quintaten was at one time much in favour as a substitute for the manual bourdon as being more transparent and less "muddy" in combination, and as a *soft* choir or echo double it is not to be despised. There are excellent examples in organs built by Messrs. A. Hunter & Sons, that in the choir division at All Souls', Langham Place, being well worth studying. The double quintaten is not so often seen at the present day, its place being taken by stops of the salicional or echo viola class, especially from tenor C of the manual upwards. The reason for this is that the light character of the 16ft. tone of the quintaten is very easily snuffed out by the unison ranks in combination, while the quint tone tends to upset the delicacy and charm of the softer 8ft. stops. The risk of failure is always a factor to reckon with, and the somewhat emasculated effect which characterises all tone productions of this type compels the designer to classify the quintaten among the fancy stops.

The chief value of the quintaten lies in its *timbre*-creating properties. The 8ft. stop can be used as a solo voice with striking effect in a resonant building, or it may be combined with a violoncello or an imitative reed and thus produce a beautiful synthetic result. Again, it may be substituted for the twelfth rank in the choir or the echo division, and indeed it were better to do this than to eliminate the prime and convert it into a zauberflöte or harmonic stopped twelfth. The 4ft. stop creates a nineteenth and is not of much use except for special *timbre* effects. The late Thomas Casson used to build up a synthetic 32ft. violone by means of a 32ft. metal quintaten (16ft. actual pipe, 9in. scale), combined with the usual pedal 16ft. stops.

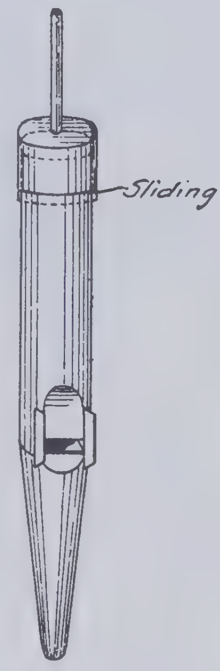
When the quintaten is so treated that the twelfth is only barely distinguishable along with the prime, it is often called "cor de nuit," so that actually the cor de nuit (night horn) is a cross between the quintaten and the ordinary metal stopped pipe or gedackt. There is an interesting specimen of the cor de nuit in the choir division of the organ at St. Elizabeth's R.C. Church, Richmond, the 16ft. octave of which is available on the pedal only, the manual portion being from 8ft. up and available in 8ft. pitch. The scaling and treatment are as follows: CCC, 5in. (zinc pipes with canister sliding tops up to BB), two-ninths mouth (rollered), no twelfth distinguishable in these two lowest octaves; CC, $3\frac{3}{8}$in.; tenor C, $2\frac{1}{4}$in.; middle C, $1\frac{1}{2}$in.; treble C, 1in.; ordinary wooden stoppers from tenor C up, and a fourth mouth. Wind pressure $3\frac{3}{4}$in.

There is also a most beautiful French example in the swell division of the fine chamber organ at Derryswood, Wonersh (the residence of Mr. John

Courage), consisting of large scaled capped metal pipes with a sixth mouth, the tone being similar to the tibia minor of Mr. Compton. A curious and interesting phenomenon in connection with this stop is the prominence of the *octave* or first upper partial in lieu of the twelfth: hence it approximates rather to an "octaten" than a "quintaten." (See also ZARTFLÖTE.)

Resultant Bass.—See ACOUSTIC BASS.

Rohrflöte (also called Chimney Flute: Flûte-à-Cheminée).—The original stop bearing this name was a large-scaled metal pipe capped at the top by means of a flat lid soldered on all round, and a narrow tube or chimney fitted into the centre of the cap. The early English builders, and Snetzler in particular, were very fond of this stop, and there can be no doubt that they had some justification, for the tone was most delightful. The tuning was performed by shading the mouth with extra long ears, thus jeopardising the regularity of the voicing. A much more satisfactory method is to adopt the sliding canister top shown in the illustration. The chimney (or reed: hence the prefix "rohr") can be inverted and fitted inside the pipe-body instead of outside; but when this is done the result is to all intents and purposes the same as that produced from the modern form of lieblich gedackt with its perforated wooden stopper. It is indeed for this very reason that the old-fashioned type of rohrflöte has become almost obsolete. At the same time, the precise *timbre* of the Snetzler pipe is peculiar to this special formation, and it would be a pity to let it drop out of existence altogether. The scale at tenor C (4ft. tone) varies from $2\frac{1}{4}$in. to $2\frac{7}{8}$in., but $2\frac{1}{2}$in. seems to give the best tone, with a two-ninths mouth and early English form of languid (see illustration on p. 18). The length of the chimney may be from a fourth to a half that of the pipe-body, a third being perhaps the most suitable. The diameter of the chimney should be a third the diameter of the pipe, though it used sometimes to be made as narrow as a sixth. The tierce or the fifth partial (17th) would appear to receive reinforcement in these pipes rather than the twelfth, so that strictly speaking the *timbre* should be somewhat nasal; yet actually there is more refinement in the rohrflöte than in the modern lieblich gedackt, and the difference can only be accounted for by the larger scaling and low wind pressure used by the old builders.



ROHRFLÖTE

No advantage is to be derived from extending the rohrflöte pipe in any of its varieties of formation below the 4ft. C; an ordinary stopped wood bass is quite sufficient.

Salicet.—An octave or 4ft. salicional *(q.v.)*.

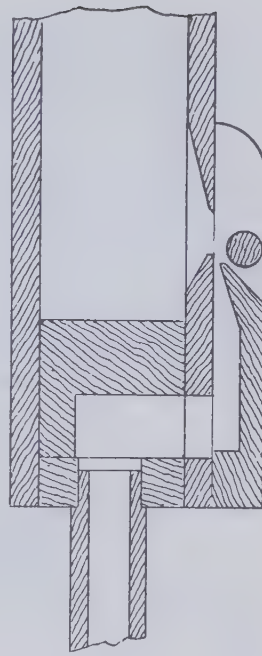
Salicetina.—A superoctave or 2ft. salicional *(q.v.)*.

Salicional (16ft., 8ft., 4ft. and 2ft.).—This name stands for quite a variety of soft flue stops of the echo diapason and string categories, according to the builder responsible for its construction and voicing. But perhaps the ideal type may be best described as an *echo geigen*. Beyond all doubt this *is* the tone of the 16ft., 4ft., and 2ft. examples, labelled respectively double salicional, salicet and salicetina. Consistently, therefore, the 8ft. stop should follow suit. As the true geigen is not legitimately slotted, it might be naturally argued that slotting is equally illegitimate in the case of the miniature stop. The question of slotting, however, is mainly determined by the absolute scaling, and when the salicional falls on or below the scale-line of 2in. at the 4ft. pipe (see HORN DIAPASON), no serious objection can be raised against the slot. The power of the stop is that of the dulciana, though a little more positive in view of its increased harmonic development. Of course the salicional, like the dulciana, varies its power according to circumstances; but it should never exceed what is understood by the mark *mp*. The scale may be anything from $1\frac{3}{4}$in. to $2\frac{1}{4}$in. at the 4ft. C, with a *fifth* mouth cut up from a fifth to two-ninths of the pipe's diameter according to the power required. Roller-bridges are essential in the bass, tenor and middle octaves of the smaller scales, but must not be placed too close to the mouth, nor should they be of the same thickness as those employed in the voicing of small-scaled viols. From treble C (1ft.) up, the bridge should be dispensed with; but the ears must be carried right through the compass. Slotting is not required in the treble register. The relative scaling should be "half on the 20th,"—that is, the diameter of C should reach its half measure at the octave G above. The scale of the CC (8ft.) pipe may be 3in. and that of the CCC (16ft.) pipe 5in. to 6in.

There are many beautiful examples of the double salicional on the choir division of the organs built by Messrs. Harrison & Harrison. These are almost invariably borrowed on the pedal. The salicet 4ft. provides a most useful echo principal for the choir or echo divisions, while the salicetina 2ft. imparts to these sections of the organ a piquancy which can be obtained in no other way. It adds a "point of silver" to every soft combination, and is vastly superior to the usual piccolo or flautino. Good examples of the salicetina exist in the choir of the organ at the Christian Science Church, Curzon Street, Mayfair, W., by Messrs. Hill, Norman & Beard, and in the same division at St. Elizabeth's R.C. Church, Richmond. The scale of the latter at the C's is as follows: CC (2ft.), $1\frac{3}{8}$in.; tenor C (1ft.), $\frac{7}{8}$in.; middle C (6in.), $\frac{17}{32}$in.; treble C (3in.), $\frac{3}{8}$in. Two-ninths mouth, wide slots. Wind pressure, $3\frac{3}{4}$in.

Saxophone.—The *timbre* of the brass instrument is of a complex character. It is perhaps best imitated on the organ by using in combination a fairly powerful clarinet and violoncello. It does not seem to be possible to reproduce the tone from a reed pipe, but Mr. W. E. Haskell, the celebrated

American voicer, has achieved signal success from a wooden flue pipe. It is practically a small scaled waldflöte *(q.v.)* fitted with ears and roller-bridges. The scale of the CC (8ft.) pipe is $4\frac{3}{16}$in. by $3\frac{5}{16}$in. The mouth is on the narrow side and inverted, with a sunk block. The upper lip is cut to a sharp edge and both lower lip and cap are closely nicked. The cut-up of the mouth at CC is a fraction below the inch. Tenor C is $2\frac{9}{16}$in. by 2in., and middle C $1\frac{17}{32}$in. by $1\frac{3}{16}$in.



HASKELL SAXOPHONE

Septime.—A mutation rank speaking the flat seventh, fourteenth or twenty-first above the unison. In organ building the seventh is very rarely used, as it is a sub-mutation even to the 16ft. stops. The normal rank is the ♭21st, which represents the seventh partial tone in the natural series, and the fourteenth occurs in the first "break" of a mixture stop. Reference to the essay under HARMONICS will acquaint the student with the right and wrong uses to which this mutation may be put. It is essentially a *timbre*-creating rank and requires the greatest care of all the mutations in its treatment. Cavaillé-Coll, Walcker and Casson, especially the French builder, have made frequent use of the rank, a signal instance being at Notre Dame (Paris). Messrs. Harrison & Harrison very often include it in their great harmonics. The pipe-length (on the label) is designated $4\frac{4}{7}$ft., $2\frac{2}{7}$ft., $1\frac{1}{7}$ft. accordingly.

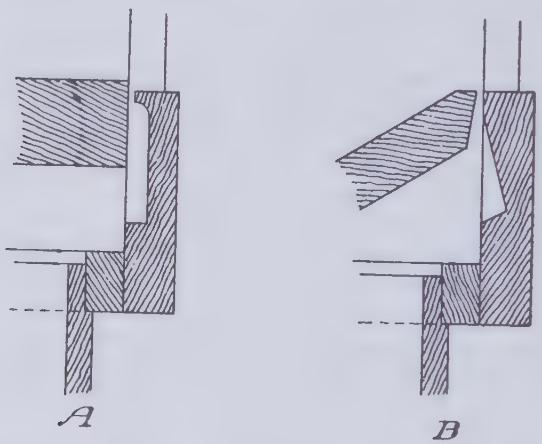
Sesquialtera.—This name is practically obsolete, though still used by some builders for their three-rank mixtures containing the seventeenth or tierce. Strictly speaking, the sesquialtera is a two-rank stop consisting of the twelfth and the seventeenth, the interval between the ranks being a major sixth; from a *timbre*-producing point of view, these are the harmonics of the stopped pipe or the clarinet, and therefore a synthetic clarinet would presumably consist of the prime and sesquialtera as at any rate the basis of its harmonic structure.

The origin of the name itself is of more than usual interest in having hitherto eluded all attempts at a correct solution. Hopkins, Robertson, Wedgwood and others erroneously derive it from the Latin word *sextus*, meaning sixth, thus making the name refer to the interval between the two ranks. The Latin word *sesquialtera*, however, does not mean sixth, but "once and a half" (that is, the ratio of 3 : 2), and the most probable explanation lies in the fact that the scale of the twelfth is exactly one and a half times the scale of the seventeenth (the proportion of $1\frac{1}{2}$ to 1).

Seventeenth.—A mutation rank speaking the seventeenth or superoctave third above the unison, thus representing the fifth partial in the natural series of harmonics. It is also called the tierce ($3\frac{1}{5}$ft. and $1\frac{3}{5}$ft.). (For further information, see HARMONICS.)

Stentor.—A prefix denoting extreme power. The Weigle stentorphone is a heavy pressure diapason with a very wide mouth (about half-way round the pipe) of the steam whistle type. In large resonant buildings such abnormal methods may give fairly tolerable results, but if special power is required, the Willis double languid is to be preferred. (See DIAPASON.)

Stopped Diapason (also called Gedackt, 8ft. tone).—The 16ft. stop is usually called bourdon; occasionally, double stopped diapason or (incorrectly) double diapason. The pedal stop is often labelled sub-bass. The



STOPPED WOOD PIPES
A English B German

4ft. stop was called nason or nason flute by the old builders, but now-a-days it is very uncommon and only used on the unenclosed choir division. (See NASON FLUTE.) When the 4ft. stop is required, the lieblich *(q.v.)* type is mostly preferred, metal pipes being more easily regulated and kept in tune.

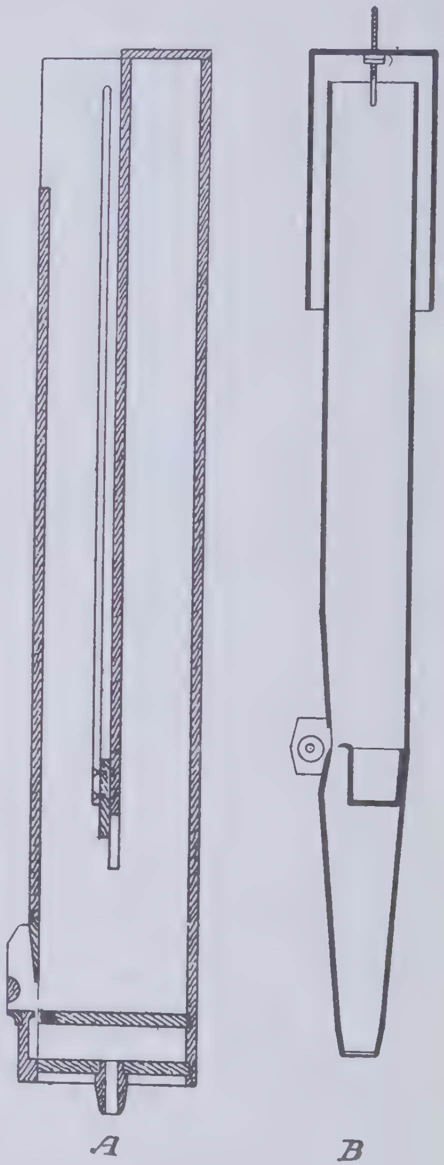
The stopped diapason is a wood or metal pipe of half length (actually a little under half length), stopped or plugged at the top with a wooden stopper or tompion lined with leather to ensure a perfectly tight fit all round. The note produced is thus made the same pitch as that of the open full length pipe. The tone, however, is by this method deprived of the even partials (octave, superoctave, nineteenth and twenty-second), while the presence of the odd series (the twelfth, seventeenth, and flat twenty-first) impart to it a curious hollow character akin to the clarinet *timbre* in the tenor and middle registers. When the stopper is perforated down its centre,

the higher odd partials are reinforced to a slight degree, with the result that the tone becomes somewhat nasal, especially if small scales are used. The rohrflöte is a familiar example of this treatment *(q.v.)*, so also was Gray & Davison's clarinet flute, now out of date. The smaller scaled stopped pipe is generally called lieblich gedackt *(q.v.)*, and though modern voicers are in the habit of perforating the stoppers, the true lieblich tone is best obtained when the top of the pipe is hermetically sealed. The formation of the metal pipe is shown under LIEBLICH GEDACKT, the only difference between the metal stopped diapason (or gedackt) and the lieblich being in the scaling employed. The middle C (2ft. tone) pipe of the lieblich is $1\frac{1}{8}$in. in diameter as compared with that of the gedackt, which is never less than $1\frac{1}{4}$in. and often as much as $1\frac{1}{2}$in. The bass and tenor octaves are usually made of wood, the metal pipe starting at middle C. The canister-top pipe is described under QUINTATÖN.

The wooden stopped pipe is the oldest type of all, but to-day is mostly employed for the lower octaves. When the complete compass is made of wood it is now felt that the beautiful examples of the early builders should be reproduced; and indeed this at least can truthfully be said of the old-fashioned stopped diapason,—it blended admirably with other stops and was eminently musical. There are two forms of construction used for the cap and block of the wooden pipe: these are shown in the illustration on page 54. A represents the old English formation, B the German. The latter is now almost always used for the 16ft. and 8ft. octaves, while the English type is still preferred by some builders for the stopped 32ft. octave; and would, of course, be adopted by anyone desiring to reproduce the early English stopped diapason from tenor C up. The difference in the voicing of A and B is practically confined within the limits of the cut-up of the mouth and the nicking of the lower lip and cap. In the German type the mouth is cut up much higher, from two-thirds the width to a height that exceeds the width of the mouth, and a comparatively larger supply of wind is admitted at the foot: hence this kind of mouth will stand high wind pressures much better than the English type. The top edges of the cap and block forming the flue being flush, no nicking is required; but if the block be formed as in pipe C diagram under DOUBLE DIAPASON (showing Mr. Pendlebury's diapason) with a bevelled languid-block and the cap fitted slightly below, then nicking is a distinct advantage. This latter type (in reality a variant of the Schulze formation) is probably the best of all for the 16ft. and 8ft. octaves. The English pipe is well plugged at the foot and cut up about a third of the mouth-width; it will not stand a higher cut-up than a half, and is therefore only suitable for soft effects. Nicking is essential. The scaling of the English type is larger than that of the German. A very good average scale at CC (8ft. tone) is 4in. by 3in.; at tenor C, $2\frac{1}{4}$in. by $1\frac{3}{4}$in.; at middle C, $1\frac{5}{16}$in. by $1\frac{1}{16}$in.; and at treble C, $\frac{7}{8}$in. by $\frac{5}{8}$in. The scaling of the 16ft. octave is given under BOURDON. The pedal 8ft. stopped diapason is variously named "flute," "flute bass," and "bass flute," and is almost invariably an extension of the bourdon.

Larger scaling still has been employed by Hope-Jones and by Compton.

The former introduced in his organs the *tibia clausa*, the scale of which was $7\frac{3}{4}$ in. by $5\frac{7}{8}$ in. at CC; and $2\frac{5}{8}$ in. by $1\frac{3}{4}$ in. at middle C. The upper lip was leathered, the voicing was on heavy wind. The stop was designed for the swell division, the idea being that the diapason phonon and the tibia clausa in combination would fatten the flue-work of this manual and enable it to cope with the high pressure reeds. That this is entirely opposed to the principles of artistic tonal design is now almost universally recognised. Chorus reeds do not require the bolstering-up of flue work, and it is a very good thing that they do not, since the utter hopelessness of maintaining equal pitch between the two classes of organ pipe under thermal variation effectually precludes any serious coalition of the two. Compton's *tibia minor* (and *tibia mollis*) is really a metal variety of the tibia clausa, but designed for the great division. The lowest octave is often of wood. The scale of the middle C pipe is about $2\frac{1}{8}$ in. with a sixth mouth (very narrow) and leathered upper lip. The tone is superior to the tibia clausa, but both stops fail in the treble register, which, admirable as it may be for an abnormal solo effect, is very unsociable in combination. It is significant that these extreme types of tone are becoming less and less a feature of modern specifications, and that the modern ear is reverting to the older and more normal types of flute tone.



HASKELL'S PATENT PIPES

The double-mouthed stopped diapason is yet another interesting variety, a description of which is given under DOPPELFLÖTE.

Lastly, there is Haskell's half-stopped pipe of metal and of wood. Both varieties are shown in the accompanying diagrams. The object of the

inventor is to produce the tone of an open pipe from a half-length one, but the saving in height is purchased at the expense of soundboard space, so that such a device is only an advantage in cases where height is strictly limited and floor space ample. Actually the pipe belongs to the category of open pipes, for the full speaking body is there, the two halves being arranged alongside, and one of them being stopped in order to preserve the continuity of the two. The same idea is also adapted to reed tubes (see TRUMPET), and in this case simply takes the place of mitreing. The fact that diapason and even string tone as well as flute can be obtained from the Haskell flue pipe shows that it does not belong to any distinct class of formation, but is merely a variation of the speaking body, and it is only mentioned under this heading for the sake of completing the subject.

String Gamba.—One of Hope-Jones's fancy names for a viola voiced in strict imitation of the early type of Thynne viole d'orchestre. (See VIOLA.)

Suabe Flute.—The name generally given to the soft 4ft. open wood flute, especially on the choir division. Often the upper lip is inverted, so that the stop is practically a small-scaled waldflöte *(q.v.)*. A singularly beautiful example by Hill exists on the choir at Great Brickhill Church, near Bletchley, Bucks., the scale at tenor C (2ft.) being $1\frac{3}{4}$in by $1\frac{3}{8}$in.

Sub.—This prefix indicates a pitch an octave below the unison. It is synonymous with contra and double,—e.g., sub-bourdon.

Sub Bass.—The name frequently assigned to the pedal 16ft. bourdon *(q.v.)*.

Superoctave.—The note sounded two octaves above the unison. The fifteenth is often so named, when the principal is called the octave. (See HARMONICS.)

Tenth.—A mutation rank sounding the tenth note above the unison, or octave above the third. It is strictly a sub-mutation in relation to the 8ft. stops of the manual, and a mutation to the 16ft. stops. It is labelled $3\frac{1}{5}$ft. on the manual, and $6\frac{2}{5}$ft. on the pedal. (See TIERCE, SEVENTEENTH, HARMONICS.)

Tibia.—In organ nomenclature this word stands for flute tone, from which all upper partials are eliminated as much as possible: accordingly, pure ground tone is designated "tibia tone." Robert Hope-Jones was the first to use the term in this special sense when he introduced the tibia plena, the tibia profunda and the tibia clausa, all of which were abnormally large-scaled wooden flutes with leathered lips treated solely with the object of producing pure foundation tone. The tibia major of Schulze (representing a class of stop familiar at the time on the Continent) was a small-scaled wooden bourdon, while the same title was also assigned in Germany to an 8ft. hohlflöte of comparatively large scale. The tibia clausa has already been

described under STOPPED DIAPASON, as (being a stopped pipe) it falls under that category. The tibia plena is an open wood pipe of the clarabella species; in fact it is merely a clarabella of large scale with leathered lip. The mouth is splayed in the same way, but the block is sunk (i.e., slopes backwards). The middle C (2ft.) pipe at Worcester Cathedral measures $3\frac{1}{4}$in. by $2\frac{13}{16}$in., the mouth being cut up two-fifths of its width. The 16ft. stop is called tibia profunda, and the CCC (16ft.) pipe at Worcester measures $15\frac{3}{4}$in. by $13\frac{3}{4}$in. These stops are voiced on heavy pressure. The tibia profunda is by no means an invention of Hope-Jones, since a large number of pedal "open diapasons" by Bevington were of even larger scale and produced a very similar effect. The only difference lies in the increase of wind pressure and the employment of the leathered lip. It has indeed been well said that the tibia plena is an extension of the pedal open of the Victorian era on to the manual in 8ft. pitch, for it is possible to reproduce the effect of the Hope-Jones stop very successfully by playing a chord on the upper octave of the pedal octave wood on an organ built in the nineteenth century.

We know quite well the reason why Hope-Jones introduced the fat-toned tibia into his great organ schemes: it was to create in conjunction with the diapason phonon (or leathered diapason) a huge mass of foundation tone, for which his mind became obsessed. There is, of course, nothing essentially wrong in the desire for that massive dignity which is so striking a feature of pure organ tone. The French conception of *ensemble* is to our ears inadequate from this very standpoint, but the Hope-Jones ideal swerved over to the opposite extreme. The tibia plena was most objectionable in close chords: its flutiness was far too intense. It hooted through every combination of which it formed an ingredient. Hope-Jones was proudly conscious of its overwhelming personality, and claimed that it provided a 16ft. effect in addition to the unisonal foundation. It was, as it only deserved to be, a nine days' wonder. To-day, how many organs of recent manufacture possess this wonder-tone? At Worcester, it was speedily transferred from the great to the solo manual. The massiveness of the 16ft. and 8ft. diapason phonon is all that the most fastidious devotee of foundation tone could desire. Pure organ tone is not synonymous with pure foundation tone, and the introduction of positive and assertive flute tone in the diapason division is thoroughly pernicious in its effect on the homogeneity of the great organ chorus.

Tibia Plena.—See TIBIA.

Tibia Profunda.—See TIBIA.

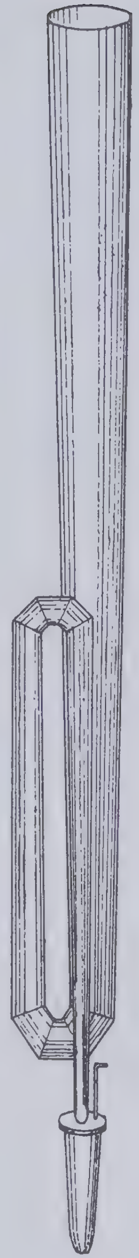
Tierce.—The seventeenth note above the unison. (See SEVENTEENTH.) The tierce is the fifth partial tone of the natural harmonic series. The special names given by builders of the past to the various mutation ranks may be enumerated here: quint (5th), nasard (12th), tierce (17th), larigot (19th), septime (21st). (See HARMONICS.)

Tiercina.—The natural harmonics of the stopped flue pipe being the prime, twelfth, tierce and septime (the odd partials), it occurred to Hope-Jones that a stopped metal pipe of small scale might be overblown to speak the tierce instead of the twelfth, and the prime note "locked" by means of the roller-bridge as in the case of the quintaten (*q.v.*). Such a stop was introduced in the famous Worcester Cathedral organ, but can hardly be said to have proved a success, since it requires careful nursing if its real character is to be preserved. It would surely be better to design a proper *timbre*-creating mixture (an echo sesquialtera) comprising these harmonics, each rank separately designed and artistically voiced, than to waste valuable time on such freakish productions as the tiercina.

Travers Flute.—See HARMONIC FLUTE.

Tromba.—16ft., 8ft. and 4ft. A powerful chorus reed of the trumpet class, of smoother and closer tone than the trumpet and not so powerful as the tuba. The whole subject of chorus reed tone is dealt with under TRUMPET. The tromba is a conspicuous feature of Messrs. Harrison's great organs, where it is frequently introduced in 16ft., 8ft. and 4ft. pitch (labelled contra tromba, tromba and octave tromba). The tone is smooth and close, and usually voiced on 12in. In a number of cases the tromba is selected by the builder as a substitute for the more powerful tuba owing to the absence of wind pressure above 10in. The scaling of this reed is generally larger than that of the trumpet and the tuba, often excessively large. $3\frac{7}{8}$in. at tenor C (4ft.) is the absolute maximum; a much more musical tone is obtainable from a $3\frac{1}{2}$in. scale. Yet as much as $4\frac{1}{2}$in. (and even $6\frac{1}{2}$in.!) has been employed by some voicers of the Hope-Jones school, and the result has been the creation of that highly undesirable type of stuffy, "honky" tone which refuses to blend either inside or outside itself. This pernicious type of chorus reed is as intractable in its own sphere as is the tibia plena in the domain of flue-work.

Trombone.—Strictly this is the 16ft. tromba and usually called by this name when placed on the pedal division. (See also OPHICLEIDE.) Any pedal 16ft. reed more powerful than a bassoon or fagotto may be labelled trombone, but sometimes the very powerful pedal reed is called "bombarde" or tuba bass (tuba profunda). Under this heading reference is made to the 16ft. pedal



MITRED TROMBONE

chorus reed as such, whatever the actual power. Trombones may be made of wood or of metal. To-day the metal pipe is more popular among builders. In the wooden pipe every part, except the tongue and tuning spring, may be of wood, and the shallot is nearly always faced with leather. The tone of the wooden trombone when properly treated is very smooth and weighty, but its adoption is only indicated where heavy pressure is not available, otherwise no advantage is to be gained from it. The metal trombone is, for economical reasons, frequently made of zinc at the unmitred portion of the tube. The process of mitreing at the tip of the tube (illustrated on p. 59) is often necessitated by the restriction of height in the organ chamber or gallery, though quite apart from this necessity the mitre proves an effectual barrier to dirt falling down the pipes. It is maintained by a number of voicers that the mitre affects the tone and is of service in controlling the graduation of resonance at the tip. That this is true of the narrow tip is not open to argument; but the application of this theory to the mitre is no less arbitrary than the widely believed statement that the use of felt is more productive of refinement in the tone than brass for weighting the end of the tongue. The use of zinc for the complete tube is not commendable, though it is possible to felt the tip at the point where it fits into the socket. Another method of adapting the full length tube to limitations of height is that invented by Mr. W. E. Haskell of America. (See accompanying sketch.) The upper portion of the resonator is cylindrical in shape and sufficiently wide to pass outside and over the lower conical tube. It is actually an elongated cover capped at the top, and it may extend right down to the tip of the lower tube provided sufficient space is left for the manipulation of the tuning spring. In the case of the diaphonic resonator even this latter provision need not be made. For trombone tubes stout metal is essential to the best results, as obviously the vibrations in the tube are very pronounced especially when high pressures are employed. The scaling varies from 6in. to 8in. at CCC (16ft.), the diameter of the tip (inside) being not more than $\frac{3}{4}$in. The length of the tube at CCC with an 8in. scale is 15ft. 10in. for a medium pitch, and 16ft. 2in. for diapason normal pitch, allowing for a regulating slot. The lowest pressure that should be used is 7in., and more if possible. The type of shallot varies with the voicer: some prefer open shallots, others (notably Willis) use closed shallots with V-shaped openings cut to a distance of about half-

HASKELL'S METHOD of shortening a reed tube

way up, the diameter of the head being $1\frac{1}{16}$in. outside and tapering to the tip in the ratio of 5 : 3. This scale of shallot is, of course, not required for the manual 16ft. reed, which would be an ordinary extension of the 8ft. scale. Whatever the diameter of the shallot head, the diameter of the boot-hole (admitting the wind) should be at least the same on all pressures. The thickness of the tongues is determined by the pressure of wind employed at the boot.[8] It is quite easy to tell whether the tongue is too thick or too thin: if too thick, the tuning length is too great, whereas the spring should never rest further up than two-thirds the length of the tongue (measured from the loose end of the tongue to the wedge) when the note is dead to pitch; and if the tongue is too thin, the note is deprived of the requisite weight and firmness and is in constant danger of "choking." It is necessary also to weight the end of the tongue so as to shorten the tuning length to two-thirds or less. The curvature of the tongue must, of course, be perfect in both quality and degree. This precise curve cannot be described in words beyond the statement that it is parabolic in form and is such that during the process of striking the shallot the tongue gradually and at a uniform rate covers the opening. If the shallot and tongue (in position) is held up in front of a brilliant light and the intervening space between the tongue and the surface of the shallot scrutinised by the eye, the process of closing down the tongue will be marked by a shadow-line travelling from one end to the other; this shadow-line should move at a uniform rate from the point at which the tuning spring is at rest to the head of the tongue. When the tongue completely covers the surface of the shallot, no light must be visible. In poorly curved tongues, the points at which light can be seen are called "flats," and the existence of "flats" is proof of inadequate curvature at that particular spot. In the case of large tongues used for trombone pipes, it is much more difficult to secure the correct distribution of curvature, although the very size of the parts examined make errors more distinguishable. It is not an exaggeration to say that the difficulties of reed voicing increase with the size of the parts, for the simple reason that the opportunity for divergence from scientific accuracy and proportion becomes greater at every pipe that brings one nearer to the bottom note. The amount of load required at the end of the tongue is determined by the thickness of the tongue, the pressure of wind and the dimensions of the tube. The voicer knows these things either because he has discovered them for himself or because the sizes have been handed down to him by his predecessors who did all the necessary spade-work and set the standard for future generations. What the art of reed voicing owes to the great Henry Willis, for instance, is not even to-day

[8] The question of the drop in wind pressure in its passage from the soundboard to the pipe is entered into on p. 20 under DIAPASON. The same principles govern the supply of wind to reeds as to flue pipes. There are quite a number of voicers who imagine that the reed boot standing on a soundboard delivering a given pressure of wind by the anemometer is actually receiving that precise pressure. Take, however, a tenor C (4ft.) reed pipe of the trumpet species and place it on a pallet pressure of 6in. If the diameter of the boot-hole be 5/16 in., the pressure *acting on the tongue* is only 3·8 in. Increase the boot-hole to 1/2 in., and the pressure in the boot at the voicer's disposal is 5·4 in. The importance of large bores is thus clearly demonstrated, for not only do we by this means increase the pressure but also the speed of the discharge, and the result is a greater momentum, which is precisely what is wanted. It is a good rule to make the boot-hole at least the same diameter as the outside diameter of the shallot-head.

fully realised, but there is not a voicer in existence worthy of the name who does not appreciate the amount of saving in labour and time that has been effected by that wonderful man, in conjunction with the other members of his house. Take the CCC (16ft.) tongue by way of illustration. For wind pressures up to 5in. a thickness of ·028in. by the micrometer is known to work very well, while for 8in. to 10in. a thickness of ·036 is required. In the latter case a load weighing $11\frac{1}{4}$ grammes (or about $\frac{3}{8}$ ounce) will enable the voicer to curve the tongue to a vibrating length of two-thirds. The weight may be either a mass of thick felt (such as is used for felting piano hammers) with a small piece of lead glued on top, the whole being glued on the end of the tongue and covering about a fifth of its surface; or, it may be, as in all Willis reeds, a brass button of special shape, as shown in the accompanying diagram. This particular form of load is screwed on to the tongue at the correct point. Supposing the CCC tongue to be $4\frac{1}{2}$in. long from the wedge, and the tuning length 3in., the position of the weight would be at a distance of three thirty-seconds of the tuning length (or a sixteenth of the tongue length) from the end. This would leave about a $\frac{1}{4}$in. of unweighted extremity, and the cone-point of the weight would rest comfortably clear of the disc-head of the shallot. The degree of tongue-curvature must be at its maximum immediately prior to the screw-hole of the weight, so that no portion of the tongue shall strike the shallot more forcibly than any other, and no tapping metallic sound shall be caused by the downward stroke. If the head of the shallot is "filled in," the weight is placed at the same distance from the edge of the plate as it would be from the disc-head of an ordinary shallot. Supposing the plate to extend up a tenth part of the shallot, the weight would be screwed on at a point one-tenth *plus* one-twentieth (equals three-twentieths) of the length of the tongue from the head. In this case, the unweighted extremity of the tongue is given an exaggerated curve to prevent it from smacking the plate. That the employment of brass weights considerably increases the difficulties of reed

REED TONGUE WITH BRASS WEIGHT

voicing is generally recognised, and the number of voicers who use them is few indeed. Franklin Lloyd loaded the tongues of the reeds he voiced for Hope-Jones in this manner (e.g., at Worcester *et passim*), and this man who introduced the tuba sonora and other smooth-toned reeds was trained in the house of the great Willis. But the majority of reed voicers to-day prefer the more convenient and less troublesome felt and lead weight. The brass weight is sometimes used with a thin pad of felt interposed between the weight and the surface of the tongue, a compromise that may be commended as by no means contemptible, especially as it enables one to dispense with glue or Chatterton's compound in favour of the screw. It may be mentioned that trombone tongues are usually curved on the Willis machine and finished to the precise parabolism required for each note by hand. It is, of course, quite possible to dispense with the curving machine, but the latter not only saves time and labour but ensures accuracy. The voicer has to adjust the positions of the spring and of the cam of this machine to suit the quality and the degree of curvature he requires for each tongue in accordance with the particular stop he is treating. The smaller tongues are best burnished by hand.

The 32ft. reed called contra trombone or contra bombarde, is accorded the same treatment as the 16ft. octave and may have either metal or wooden tubes. Naturally, the large, heavy tongues required in the 32ft. octave are apt to be sluggish in starting to vibrate. This defect is successfully overcome by the employment of a pneumatic starter or controller. The weight at the end of the tongue is connected by a tapped wire to a pneumatic motor (a small bellows): this motor is fixed to the outside of the wooden boot of the reed in a vertical position and covers a small hole in the boot. When wind is admitted to the boot, it immediately inflates the motor and simultaneously sets the tongue in motion. As soon as the wind supply is cut off, the spring on the motor stops the tongue from vibrating. There are many fine examples of the 32ft. pedal reed in this country. Strange to say, Father Willis failed in this octave through using inadequate wind pressure, but retrieved his reputation at Lincoln Cathedral. The present firm have produced magnificent examples at Huddersfield Town Hall, and Hereford Cathedral on 12in. and 16½in., respectively. An interesting example of an enclosed 32ft. reed occurs in the swell pedal division at St. Mary Redcliffe, Bristol, by Messrs. Harrison & Harrison. Half-length tubes are sometimes used for economy, the scale of the 32ft. octave being the same as that adopted for the full length 16ft. octave. The scale of the CCCC (32ft.) pipe at full length is 12in. The new 32ft. pedal reed just installed at Westminster Cathedral by Willis on 30in. wind is the first voiced on so high a pressure. The load on the CCCC tongue weighs as much as 4 ounces, the tuning length being about 3½ in. (See also DIAPHONE.)

Trompette.—A chorus reed so labelled in an English organ should imply that the tone is a reproduction (more or less) of the French type of trumpet with open shallots: in short, that the free-toned chorus reed is represented. (See TRUMPET.)

Trumpet.—16ft., 8ft. and 4ft. The name "trumpet" stands for the *normal* type of chorus reed tone, and its ideal presentation is that which has been bequeathed to us by the genius of Henry Willis the first. It is necessary, if the student is to have right and sane ideas about reed tone, that he should recognise the existence of three types of chorus reed. They are distinguishable thus: the normal, the close and the free. Even these have their sub-divisions, but every species of reed tone can be classified under the three groups afore-mentioned, just as all flue tone can be divided into the three classes known as diapason, flute and string.

(*a*) The *normal* type of chorus reed is, as we have already seen, the product of Willis, examples of which, in the varying forms of trumpet, cornopean, posaune and tuba, are to be heard in all the magnificent instruments bearing his name. These reeds constitute a class of tone that distinguishes them from all others in spite of the real differences that subsist between them. The "splash" of the trumpet and the "monitory clang" of the tuba are by no means identical tone-creations differing in power only; but this fact does not prevent us from classifying them under one *genus*. The essential characteristic of the normal type is *its capacity to create a chorus*; it is the diapason of reed tone. This class of reed can only be produced on the Willis system: that is to say, by the use of Willis scales, shallots, tongues and general scientific treatment. The recognition of this fact will save a vast amount of waste energy on the part of voicers who imagine that one type of reed can be produced by the system which produces quite a different type.

(*b*) The close reed was introduced by Robert Hope-Jones in 1895, but it is only fair to record the fact that the first examples were voiced by E. Franklin Lloyd, who had been trained in the Willis voicing-room. Hope-Jones named his (then) novel type the tuba sonora, but this title has been dropped for many years, and the modern closed-toned reed enjoys the names of *tromba* and *horn*. What the flute is to the diapason, the close reed is to the normal type; and just as the clarabella should be subservient to the diapason chorus, so should the close reed occupy the same relative position in the reed chorus.

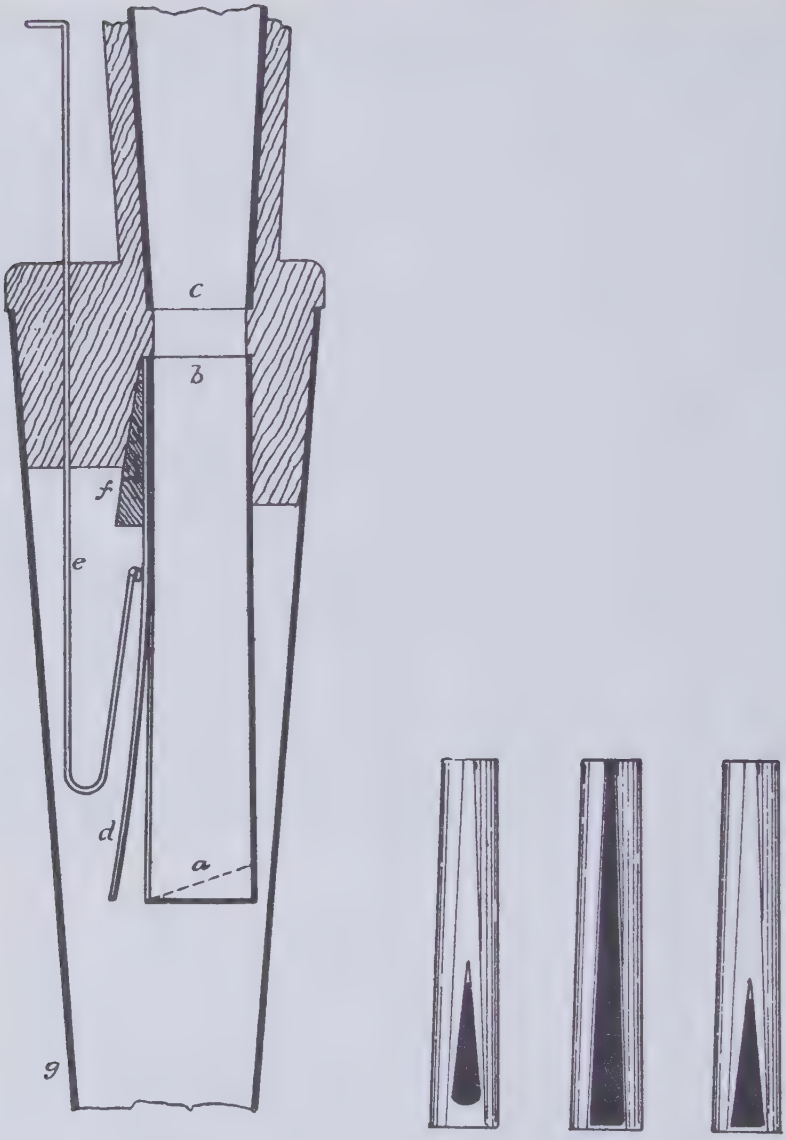
The three main factors in the treatment of this class of reed are: (1) closed shallots; (2) harmonic tubes,—i.e., double length; and (3) high wind pressure. Willis as far back as 1870 had been using all

TRUMPET
(hooded)

three in the treatment of his magnificent tubas: hence we see that the Hope-Jones tuba sonora was but the ultra-development of the Willis tuba in the direction of closeness. Somewhat thicker tongues were employed to enable the voicer to tune the reed to a closer (sharper) pitch without causing the tongue to "choke." The tuning length of the tongue was further controlled (shortened) in the lower half of the compass by the process of loading, which was carried up an octave and a half higher than in the Willis reed, the higher notes being weighted with felt loads. Franklin Lloyd adhered to the brass weights with which his Willis training had familiarised him; but later voicers introduced felt and lead weights in the bass and tenor octaves, omitting the lead in the higher portion. The question of loading is dealt with under TROMBONE. Another deviation from the Willis standard was the increase of scaling adopted for this type of reed. The standard scales for chorus reeds set up by Willis run from a maximum of 5in. to a minimum of $3\frac{1}{2}$in. at CC (8ft.), and the tips of the tubes are scaled in proportion, varying from a tenth to an eleventh of the top diameter. The half measure falls on the thirty-second note in the relative scaling of the 8ft. octave (from CC to tenor C); from this point upwards the ratio is increased to half on the thirty-seventh or thirty-eighth. The diameter of the octave above a given note in the former ratio can fairly accurately be obtained by multiplying the diameter of the larger pipe by $\frac{3}{4}$ (or ·76), while the latter measure can be ascertained by multiplying by $\frac{9}{11}$ (or ·81). The following schedule of scales will give the student a very fair idea of the relative diameters of the various C's. The 16ft. octave is worked to a different ratio, varying from half on the eighteenth to half on the twenty-third. It must, however, be borne in mind that these ratios are, within certain prescribed limits, capable of modification in accordance with the special conceptions of various voicers; also that these are the diameters of the pipes prior to the operation of voicing and cutting to exact length.

CCC (16ft.)	7 in.	$6\frac{1}{2}$in.	6 in.	$5\frac{1}{2}$in.	5 in.
CC (8ft.)	$4\frac{1}{2}$in.	$4\frac{1}{4}$in.	4 in.	$3\frac{3}{4}$in.	$3\frac{1}{2}$in.
Ten.C(4ft.)	$3\frac{3}{8}$in.	$3\frac{1}{8}$in.	3 in.	$2\frac{7}{8}$in.	$2\frac{3}{4}$in.
C^1 (2ft.)	$2\frac{3}{4}$in.	$2\frac{5}{8}$in.	$2\frac{7}{16}$in.	$2\frac{3}{8}$in.	$2\frac{5}{16}$in.
C^2 (1ft.)	$2\frac{1}{4}$in.	$2\frac{1}{8}$in.	2 in.	$1\frac{15}{16}$in.	$1\frac{7}{8}$in.

The large Willis scale of 5in. at CC (8ft.), according to the above measurements, would run thus: CCC, $7\frac{1}{2}$in.; CC, 5in.; ten. C, $3\frac{7}{8}$in.; mid. C, $3\frac{1}{8}$in.; treble C, $2\frac{5}{8}$in. As a matter of fact, the large tubas of Willis are not scaled in this ratio: the tenor C pipe would be $3\frac{1}{2}$in., and the half on the 37th ratio would proceed from this point upwards. The rule as to double length harmonic tubes is that the scale is the same as that of the normal length tube an octave below: so that if the middle C pipe of the CC $4\frac{1}{2}$in. reed, for instance, be harmonic, the diameter will be $3\frac{3}{8}$in., that of the treble C pipe will be $2\frac{3}{4}$in., and so on. Now, it may be surmised that somewhat larger scaling than that above given would be beneficial to the production of close tone. This is a chimera that many voicers have been able to dispel for



A B C D

A. Beating Reed
B. Filled in Shallot
C. Open Shallot
D. Closed Shallot

a. Head of Shallot
b. Tip of Shallot
c. Tip of Tube
d. Tongue
e. Tuning Spring
f. Wedge
g. Boot

themselves. As much as 6½in. has been used for the tenor C (4ft.) pipe of a tuba, while at Worcester Cathedral Hope-Jones made the tenor F pipe of his solo tuba to the enormous scale of 8in.! The tuba (voiced by Mr. Rundle on 14in.) at the Wesleyan Central Hall, Westminster, is 5½in. at CC, and represents the boundary beyond which it is quite unnecessary (and, indeed, incompatible with high art) to go. This stop is an excellent example of close tone, the scaling of the harmonic portion dropping to 3⅞in. at middle C. On pressures above 10in., the first harmonic pipe should be tenor F♯, and for this pipe the scale of 3⅞in. need not be exceeded. It must be remembered that excessive scaling in the tenor octave has a pernicious effect upon close chords played in this register. The close-toned trombas of Messrs. Harrison & Harrison have been referred to under TROMBA. Their tubas at York Minster (on 25in.) and at Wells Cathedral (on 20in.) are, strictly speaking, trombas.

(*c*) The free-toned reed is associated with the French or Cavaillé-Coll school, and corresponds to the viol class in the domain of flue-work. Small scaling, open or elongated V-shaped shallots, relatively thin tongues, and the exclusion of harmonic tubes (except for the top octave or so) are features which may, either singly or in combination, characterise the type. Very good results can be obtained from comparatively low pressures, though anything below 5in. is not recommended under normal conditions. Here, as in all types of chorus reed, pressure determines the power.

This class of reed is specially suited to enclosure: it finds a natural home in the swell division, thus providing the requisite tonal contrast between this department and the great. Perhaps the best name for the type would be "trompette," and then it can more readily be distinguished from the normal Willis trumpet. In the Westminster Cathedral swell division the unison chorus reed is thus labelled: it has open shallots and speaks on 15in. pressure. A very fine low-pressure specimen (on 3½in. only) by the same voicer may be heard in the swell of the remarkable chamber organ belonging to Mr. John Courage at "Derryswood," Wonersh, Guildford. It is, however, not essential to adopt the open shallot, since there is more than one species of free-toned reed. The Willis swell reeds at Salisbury Cathedral have closed shallots (open about half-way up) and are wonderfully brilliant on their very moderate pressure of 4½in. Another example of the type occurs on the choir of the Willis organ at St. Saviour's, Ealing, labelled (rather anomalously) "cornopean." The swell 16ft., 8ft., and 4ft. trumpets at St. Mary-Redcliffe, Bristol, by Harrison, are good modern illustrations, voiced on 12in. It is questionable whether this very positive type of tone should be carried beyond the unison stop even in the swell division, except in a luxurious scheme where other more normal types can be represented in addition. In a swell of moderate dimensions one 8ft. trompette will suffice, the double reed and the clarion being voiced on normal Willis lines. The provision of sub and super octave couplers would make it possible to secure a special free-toned chorus for an occasional effect, the double being omitted from the combination. If, in addition to this, the double reed were made

available on the pedal, the incomplete effect of the suboctave coupler would be minimised.

The recognition of these three categories of chorus reed tone is essential to the realisation of the possibilities of the modern organ. At the same time their use must be governed by the laws of proportion and combination. Tone-qualities that deviate from the normal are ever dangerous things to handle, and there are unfortunately amongst us those who in their enthusiastic attempts to *normalise the abnormal* prove that they have yet to learn from the mistakes of Robert Hope-Jones. And again, deviations lend themselves to exaggeration with fatal ease, so anxious are we to introduce something that is strikingly original and to forget the claims of the whole. Even the natural desire for *contrast* (equally effective in the sister arts of music and painting) should be controlled by true æsthetic principles. It is possible to push the contrast to such an extreme that the result is more grotesque than beautiful. Let the architect first fix definitely in his mind the normal standard for chorus building, and then he will discover for himself the right and wrong uses of eccentric types.

When we speak of the chorus reed, we ought to visualise the complete entity, and not merely the unison rank. Nevertheless, it is important to realise that less latitude is admissible in the extreme ends of the compass than in the central register. The double trumpet and the clarion (i.e., the trumpet in 16ft. and 4ft. pitches respectively) may be treated on close, free or normal lines; but if too much freedom is imparted to the tone, they lose their correct blending properties. As a general rule it is safer to confine these two ranks to normal and close treatment, the normal type being called double trumpet and clarion, and the close type contra and octave tromba. The double English horn of Hope-Jones was a typical example of ultra-free trompette tone in 16ft. pitch, but is now rightly regarded as a perversion. The clarion, if accorded the same treatment, would not only prove offensive in the chorus, but would also give trouble to the tuner. A close-toned double is invariably effective, as it gives the requisite weight to the *ensemble.* The normal harmonic clarion seems to fit in best with all reed choruses, for if it is too close it is not sufficiently assertive. In short, it is easy to see how necessary it is for the designer and finisher to exercise his artistic faculties to the highest degree if he is to attain success in the building up of a reed chorus.

Tuba.—16ft., 8ft. and 4ft. This name is reserved for the more powerful type of chorus reed intended to dominate the reed chorus in much the same way as the "brass" dominates the orchestra. Like the trumpet and the tromba, there are several varieties of tuba projected by various builders: some are quite close-toned, others of the free-toned French type. The real tuba is that which Henry Willis perfected half-a-century ago voiced on wind pressures of 15in., 20in., and 25in. according to the power required. We may cite the following famous examples which are still as magnificent to-day as when they were first put in: St. Paul's Cathedral, Glasgow Presbyterian Cathedral, St. Patrick's Cathedral, Dublin, Salisbury Cathedral, Hereford

Cathedral, Canterbury Cathedral, St. George's Hall, Liverpool, Royal Albert Hall, London. At Westminster Cathedral the tuba magna on the unenclosed solo division is voiced on 30in. The new Liverpool Cathedral organ will contain a tuba magna on 50in. Mr. Compton is also employing this latter pressure for his tuba at the Pavilion Cinema, Shepherd's Bush, while Hope-Jones used the same pressure for the enclosed tuba at Ocean Grove, New Jersey, U.S.A. This last, however, is a close-toned reed of the tromba class.

At the basis of the treatment of the tuba lies the harmonic tube, and the large-scaled closed shallot. The scaling of the pipe does not in the Willis examples differ from the standard scales mentioned under TRUMPET, the maximum being 5in. at CC (8ft.). The double length tubes commence at tenor F♯ (above tenor C), the diameter of the tenor F♯ tube being the same as that of the FF♯ normal tube (about $3\frac{3}{4}$in.). The shallot for the CC pipe has the following measurements: length, $4\frac{3}{8}$in.; diameter at head (outside), $\frac{3}{4}$in.; diameter at tip (inside), $\frac{3}{8}$in.; length of opening, $1\frac{7}{8}$in.; width of opening at base, $\frac{3}{8}$in. Compare these proportions with those of the CC shallot of an ordinary trumpet or small tromba, and we shall be better able to visualise the difference. The CC trumpet shallot is 4in. long, its head is $\frac{21}{32}$ in. wide (outside), its tip is $\frac{5}{16}$ in. diameter (inside), the opening may be as long as that of the tuba or it may be a little shorter (usually $1\frac{1}{2}$in.), and the base of the opening is $\frac{9}{32}$ in. wide. In short, the scale of the CC trumpet shallot is equivalent to that of the FF note of the tuba with the sole exception of its length, the length of the FF tuba shallot being $3\frac{3}{4}$in. When the harmonic treatment begins, not only is the tube lengthened but the shallot also, though not in the same degree. We know that the tube is made double the normal length:[4] the shallot is the same size as that used for the normal note and tube, but is made a little longer to enable the voicer to increase the tuning length of the tongue. Thus the first harmonic pipe (tenor F♯) would have a shallot of the same *scale* as the tenor F♯ shallot: its *length* would be that of the FF♯ shallot; and from this point up, the harmonic shallots would have the lengths of the corresponding sub-octaves. The following list of shallot scales shows the relative scaling of the tuba shallot from CC to top C. Non-harmonic lengths are given. For instance, the normal length of the middle C shallot is $2\frac{9}{16}$ in.; but if the tube be harmonic the shallot will be $3\frac{1}{8}$in., the length of the tenor C shallot.

	CC	ten. C	mid. C	treble C	C^3	C^4
Length of shallot	$4\frac{3}{8}$in.	$3\frac{1}{8}$in.	$2\frac{9}{16}$ in.	$1\frac{27}{32}$in.	$1\frac{5}{16}$in.	1in.
Length of opening	$1\frac{7}{8}$in.	$1\frac{1}{4}$in.	1 in.	$\frac{3}{4}$in.	$\frac{9}{16}$in.	$\frac{7}{16}$in.
Diameter of head (outside)	$\frac{3}{4}$in.	$\frac{9}{16}$in.	$\frac{1}{2}$in.	$\frac{3}{8}$in.	$\frac{5}{16}$in.	$\frac{1}{4}$in.
Diameter of tip (inside)	$\frac{3}{8}$in.	$\frac{5}{16}$in.	$\frac{1}{4}$in.	$\frac{7}{32}$in.	$\frac{3}{16}$in.	$\frac{5}{32}$in.
Width of opening base	$\frac{3}{8}$in.	$\frac{1}{4}$in.	$\frac{3}{16}$in.	$\frac{5}{32}$in.	$\frac{1}{8}$in.	$\frac{7}{64}$in.

[4] Harmonic pipes are sometimes fitted with triple or even quadruple length tubes. This is quite unnecessary, save (possibly) for French horn tone.

On pressures below 12in., it is not necessary to carry the reed pipe above D^3, as an excellent match can be made with flue pipes at this point. At All Saints', St. John's Wood, the 9in. tuba breaks into flue pipes at this note and the transition is practically indistinguishable. The D^3 reed pipe is $1\frac{7}{8}$in. diameter (harmonic) and $9\frac{1}{4}$in. long; the D sharp flue pipe is $\frac{5}{8}$in. diameter with a fourth mouth cut up $\frac{3}{16}$in. and the foot-hole $\frac{3}{16}$in. diameter. The pipe is not slotted: its speaking length is $4\frac{3}{4}$in. The pitch of the organ is C = 528. In the same way, a 4ft. clarion can be continued up in flue pipes from treble C or D of the manual compass. The question of tongue treatment is discussed under TROMBONE. The 16ft. tuba is similarly treated, the shallots being scaled in ratio. The octave tuba (often called tuba clarion) is merely an extension of the harmonic portion of the tuba. A complete family of tubas on the solo division is always an outstanding feature of a large organ. As a general rule, tubas are best enclosed; but there are special cases where a tuba is in serious danger of losing its position as a dominant personality by being packed away in a box. Since there can be no hard and fast rule, the artist alone can decide.

Tuba Clarion.—An octave tuba. (See TUBA.)

Tuba Magna.—A tuba of extraordinary power. The 30in. tuba at Westminster Cathedral and the 50in. tuba at Liverpool Cathedral are so named. When such abnormally high pressures are used, special thickness of metal is required for the tubes to resist the intense vibration; otherwise a "blaze of dissonant partials" is let loose. (See TUBA.)

Tuba Major.—In a scheme containing two tubas of different powers, the larger tuba is often called by this name. (See TUBA MINOR.)

Tuba Minor.—The smaller of two tubas in the same organ, the larger being called the "tuba major" (*q.v.*). The name "tuba minor" is often, however, applied to a single tuba, even when its relative major is absent from the scheme. It then signifies that the stop so named is a minor example of the standard tuba, possessing the real tuba quality but in a lesser degree, and the *raison d'être* of such a tuba is the limited high pressure of wind available or else the smallness of the building for which the stop is designed as suitable. It must be pointed out that the tuba minor is not a tromba, even though the line of demarcation may be very slight. The tromba is essentially a close-toned reed, and treated as such: the tuba minor has a freer development of harmonics and belongs to the category of normal chorus reed tone. (See TRUMPET.)

Tuba Profunda.—The name given by Hope-Jones to the 16ft. tuba sonora or trombone of the close type.

Tuba Sonora.—This name was originally coined by Hope-Jones to designate his new departure in smooth chorus reed tone. At Worcester Cathedral and McEwan Hall, Edinburgh, wooden shallots with double tongues (fitted either side) were used [now obsolete]. (See TRUMPET.)

Twelfth.—A mutation rank sounding the twelfth note above the unison, and marked $2\frac{2}{3}$ft. on the manual, $5\frac{1}{3}$ft. on the pedal. This mutation represents the third partial tone in the natural series of harmonics, and coming as it does between the octave and the superoctave, it is thought to bind the two octave ranks together. That it is the most important of all the mutations is not open to question. It is best made of flute-toned pipes or of early English diapason pipes in accordance with the design of the flue chorus of which it forms a part. In its capacity as a *timbre*-creator the stopped harmonic or zauberflöte twelfth would seem to be the best type. (See HARMONICS.)

Twenty-first.—See SEPTIME.

Twenty-second.—The octave rank above the superoctave or fifteenth, sounding the third octave note above the unison. (See HARMONICS.)

Unda Maris.—A flute-toned céleste. (See VOIX CÉLESTES.)

Viol.—The generic name for string-toned stops. (See VIOLA for particulars of the treatment and voicing of this category of flue stop.)

Viola.—16ft., 8ft. and 4ft. This belongs to the class of flue pipe which is distinguished by its abnormal development of harmonics, known as string or viol tone: it is thus the antithesis of the flute. There are varying degrees of pungency in organ string tone, marking the historical development of this *genus* from the viola da gamba of William Hill (formed of bell gemshorn pipes) to the tiny scaled viole d'orchestre of Hope-Jones voiced by William Whiteley. To-day, the milder forms of viol are grouped under stops of the salicional class if moderately powerful, while the softer variety are termed echo viols or muted viols in accordance with the treatment applied to them. The powerful viol of large scale is a violoncello provided its harmonic development exceeds that of the geigen.

The name *viola* stands for the normal type of viol tone. The limits of scaling (taken at the CC, 8ft. pipe) fall between $3\frac{1}{16}$in. and $2\frac{1}{2}$in. The viol of larger scale becomes a violoncello, as before stated; the viol of 2in. scale (at CC) or less is usually given the inappropriate name of "viole d'orchestre," which is the French for orchestral viola. To find a proper name for the thin, pungent tone of these viols is no simple matter. It is not in the least like the viola, and the nearest approximation would be to the tone of the cor anglais or the musette. But the latter qualities are not accurately represented by that of the small-scaled viol. Perhaps the best title from all points of view would be *æoline*, which at any rate can hardly be regarded as unsuited to this type of tone. Anything approaching loudness in these viols is to be deprecated, for they are capable of an intensity of string which is coarse to a degree unless artistically restrained. The smallest scale adopted was that at Worcester Cathedral, voiced by Whiteley: it is in the enclosed choir division, the CC (8ft. tone) measuring $1\frac{1}{16}$in. The $1\frac{1}{2}$in. scale at CC, introduced just prior to the Worcester example by

Mr. J. C. Hele in September, 1895, was also frequently used by Hope-Jones, the tenor C pipe being 1in. Generally speaking, so diminutive a scale is unnecessary, $1\frac{1}{4}$in. at the 4ft. pipe being as small as anyone can want, with 2in. at CC. The right place for such viols is in the echo division with or without a céleste rank as a partner; in other words, they should be reserved for distant etherial effects.

At the opposite extreme lies the violoncello, the scaling of which may be anything between $3\frac{1}{8}$in. and 4in. at CC (8ft.). The best results are obtained from the larger scales on heavy wind pressure. Willis has voiced a very fine specimen for the solo division at the Victoria Hall, Hanley, with French flatting for the upper and lower lips, the scale being 4in. at CC and the pressure 6in. The wooden violoncellos of Schulze, Pendlebury and Whiteley are described under VIOLONE.

The normal type of viol is associated with the name of William Thynne, who introduced his fine string tones in 1885. Prior to this there was no real string tone to be heard apart from Schulze's wonderful wood stops at Armley, Hindley and elsewhere. Schulze's metal string stops would not be classed as viols in the modern acceptation of the word, and in any case they were handicapped by the absence of the roller-bridge, the use of which revolutionised this department of voicing. Oddly enough, Schulze was no stranger to this device, since he adopted it for his wood string stops. The Thynne "viole d'orchestre" was indeed a great invention, and those who made its acquaintance for the first time must have experienced some thrills. His scales varied from $3\frac{1}{16}$in. to $2\frac{1}{2}$in. at CC (8ft.), the introductory specimen at the 1885 Exhibition (now in Tewkesbury Abbey) being $2\frac{1}{2}$in. There are numerous examples of this scale by Thynne: St. John's, Richmond, possessing the most advanced type evolved by this artist. An excellent example of the $3\frac{1}{16}$in. scale is to be found in the swell division at All Saints', St. John's Wood, where the viole d'orchestre and célestes are by Thynne. The Hope-Jones "string gamba" (an absurd name) has the same scaling, the Worcester Cathedral example, voiced by Whiteley, being a magnificent work of art.

VIOLA

The principles governing the voicing and treatment of viols must next engage our attention. We have already seen that small scaling is a fundamental factor in the production of string tone, and we have seen what that scaling is. To complete the subject of scaling, however, it may be well to give the diameters of the various C's of the main types in general use.

CC (8ft.)	Ten. C. 4ft.	Mid. C (2ft.)	Treb. C (1ft.)
(1) 4 in. ('cello)	$2\frac{3}{8}$ in.	$1\frac{1}{2}$ in.	$\frac{15}{16}$ in.
(2) $3\frac{1}{8}$ in. ('cello)	2 in.	$1\frac{3}{16}$ in.	$\frac{7}{8}$ in.
(3) $3\frac{1}{16}$ in. (viola)	$1\frac{7}{8}$ in.	$1\frac{1}{8}$ in.	$\frac{3}{4}$ in.
(4) 3 in. (viola)	$1\frac{3}{4}$ in.	$1\frac{1}{16}$ in.	$\frac{11}{16}$ in.
(5) $2\frac{3}{4}$ in. (viola)	$1\frac{5}{8}$ in.	1 in.	$\frac{5}{8}$ in.
(6) $2\frac{1}{2}$ in. (viola)	$1\frac{1}{2}$ in.	$\frac{15}{16}$ in.	$\frac{9}{16}$ in.
(7) 2 in. (æoline)	$1\frac{1}{4}$ in. (or $1\frac{3}{8}$ in.)	$\frac{3}{4}$ in.	$\frac{15}{32}$ in.
(8) $1\frac{1}{2}$ in. (æoline)	1 in.	$\frac{5}{8}$ in.	$\frac{7}{16}$ in.
(9) $1\frac{1}{8}$ in. (æoline)	$\frac{13}{16}$ in.	$\frac{9}{16}$ in.	$\frac{11}{32}$ in.

With the exception of No. 1, all the above scales can be used with low pressures. The fractions are worked out to the nearest thirty-second of an inch. The scale ratio is usually half measure on the twenty-fourth for Nos. 8 and 9, while Nos. 3 to 7 halve on the twentieth. Nos. 1 and 2 are not quite regular from CC to ten. C, but halve on the eighteenth from ten. C up. Nos. 1, 2, 3, 4, 6 and 7 are the most generally useful scales. The bass octave is almost invariably made of zinc, and there is really no advantage to be derived from the adoption of any other kind of metal. It is even possible to construct a complete stop of zinc pipes, as Vincent Willis has proved, without the slightest detriment to the quality of tone. The only disadvantage is the greater difficulty in making and voicing these slender pipes. The author has in his possession a set of top octave zinc viol pipes voiced by Vincent Willis with the roller bridges made of $\frac{1}{16}$ in. gauge wire and held in position by a wire spring soldered to the pipe-foot. The scale follows No. 7 (above). Still, most voicers prefer (with some justification) spotted metal or tin, from (at any rate) tenor F♯ up.

The average mouth-area employed for viols is two-ninths the pipe's circumference in width, with a cut-up of a third of this width. This area is subject to slight variations in accordance with the quality and the strength of tone required by the voicer. Obviously, the cut-up would be reduced for softer string tone on lower pressure. Generally speaking, the two-ninths width is the best, especially from CC to treble C. The fifth mouth is only suitable for the bass and tenor octaves of the smaller scales, such as Nos. 7 to 9. When it is employed for the larger scales, or for the upper octaves of viols generally, the true viol tone is lost and becomes merged into that of the salicional and the sourdine class. In the treble register, the width of mouth is usually increased to a fourth or even two-sevenths, in order that the requisite strength may be preserved in this portion of the stop. Although Thynne used a very wide mouth (as much as a third) in the treble, which fact accounts for the comparative flutiness of his viols in this register, anything beyond a fourth is not recommended unless heavy pressure is available, and even so only for the purpose of producing a broad 'cello effect. It

is most difficult to secure a regular uniform result with these wide mouths, owing to the fact that they encourage the well known vibratory impulses set up at the flue from the foot and the soundboard. Heavy pressure and a narrower mouth facilitate the voicing of these pipes to a considerable extent, and certainly make for increased tonal output. The above-mentioned phenomenon, which so adversely affects the speech of small viol pipes, is mainly associated with a deficient wind supply from the pallet-hole of the soundboard. The wider the mouth, the greater demand for wind is set up. The most practical and economical method of combating this difficulty is to adopt a fourth mouth as the maximum, long pipe-feet (pierced with a fairly large membrane-covered hole if necessary), soundboard pallet-holes as large as convenient for the toes of the pipe-feet, and (if possible) a wind pressure exceeding 4in.

The correct placing of the roller-bridge is of supreme importance. The student must distinguish between the various type of *frein* or beard which have been used by voicers during the past seventy years. The flat-shaped piece of wood or metal attached to the underside of the ears is the only device deserving the name of "beard." It is required solely for pipes of large scale (compared with viol scales) which have a tendency to slowness of speech, but at the same time would suffer if unduly obstructed at the mouth. The Gavioli *frein*, invented by Charles Lemaire of Paris, is an adjustable bridge of curved metal attached at its tail end to the foot of the pipe, while the Willis *frein* described above is a modification of this. It is now condemned on account of its adjustability (a feature which was claimed by the inventor to prove its superiority), for the extreme delicacy of adjustment required makes it imperative that the *frein* should remain in its final position: in other words, adjustability means instability. The roller-bridge is the latest and best form of *frein*. It is very easy to keep standard sizes of roller-stick and cut off the lengths required for each pipe. After the final adjustment the roller is fixed to the ears by means of pins or small screws. Thynne used metal rollers, and sometimes semi-cylindrical in form, the round portion being placed inwards. These types would, of course, be soldered on to the ears. Whiteley has made frequent use of aluminium tubing held in position by points punched inward at the ears. If wood be chosen, it should be close-grained and hard, such as box-wood, and polished or aluminium-silvered.

The function of the bridge is actually to prevent the pipe from settling on to one of its harmonics instead of the prime tone, hence the name given to it by Lemaire of "harmonic-curb." Physically, it amplifies the vibrations of the static waves at the pipe's mouth. It must be remembered that the emergent wind-stream executes a fan-like movement between the flue and the upper lip, the free end of this aerial reed brushing the upper lip. The introduction of the bridge causes the pendular waves to swing to and from the mouth with longer strokes, thus encouraging the prime without doing so at the expense of the overtones. The *modus operandi* in the voicing of viols is to make the pipe speak its octave (or in the case of the smaller scales its twelfth) and then to fix the bridge in such a way as to re-introduce the

prime. Often, after this is done, the sub-octave hum note is distinctly audible, especially from the 2ft. pipe upwards. The position of the bridge is close to the lower lip, leaving a very narrow passage between the two, and ample space between the bridge and the upper lip. There is a tendency among modern voicers to place the bridge too close to the lower lip in relation to the scale of the pipe. Scales Nos. 1 to 6 do not require this close position, and Thynne never adopted it. The diameter of the roller also should not be larger than what is necessary to the performance of its function: the rule is to increase the diameter with the increased pipe-length. Thus a CC pipe requires a larger bridge than the tenor C pipe, the tenor C than the middle C, and so on; also, following the same rule, the tenor C pipe that measures $1\frac{1}{4}$in. in diameter requires a proportionately larger bridge than a $1\frac{1}{2}$in. scale tenor C pipe, since the speaking length of the narrower pipe is greater. The proportionate diameters for the bridge at the various C's may be illustrated by the following schedule for the $2\frac{1}{2}$in. CC scale viola:—

CC, $\frac{5}{8}$in. Ten. C, $\frac{3}{8}$in. Mid. C, $\frac{1}{4}$in. Treb. C, $\frac{3}{32}$in.

Beyond treble E the bridge is not needed except for scales less than $2\frac{1}{2}$in. at CC, and even then not above treble A or B♭. The bridge is often carried unnecessarily high up the compass, when all that is required is to cut up the mouth a little more and raise the languid. Very small pipes have a tendency to "spit" when bridged, and even with the smallest scaling the thinner the roller the better.

The cut-up of the mouth is determined by the scale and the power aimed at. Pressure of wind is as a rule best controlled at the foot, though the voicer must use his discretion as to how far the pressure will enable him to increase his cut-up. Under no circumstances should it be necessary to cut up above four-elevenths of the mouth-width, while on the other hand anything less than two-sevenths produces a scratchy, unmusical tone when voiced up to the requisite strength. It comes to this, that a little more or a little less than the third cut-up represents the practical limits for viola voicing.

There is, again, a prevalent idea among voicers that a wide flue is essential, and the tendency is to exaggerate it. Very often a firmer note can be obtained by this means, and a comparatively wide flue is necessary for string stops of the 'cello and viola class; but, granting this, the principle still holds good that the flue should be kept as narrow as possible with each pipe that is so treated. The blending properties of the viol are not enhanced by an exaggerated flue. The same warning is applicable in the case of nicking, which may be easily overdone. Thynne's nicking was fine and close. For low pressure work, a few shallow nicks answer best. Whiteley prefers to nick the languid sufficiently for the purpose of eliminating the "spit," and to finish off on the lower lip as required. Most voicers nick the languid and lip simultaneously, but it is nice to think that variations of detail are possible.

The process of cutting away the ears above and below the bridge, thus converting them into a mere support for the latter, was devised by Whiteley and certainly assists the voicer in the production of prompt speech. The ears are, like the bridge, external air baffles; but too confined an atmosphere is bad, especially in front of the upper half of the mouth. The larger the bridge, the more desirable is it that the ears should be cut away.

It is the custom to slot all viol pipes, tuning them by means of tin slides which regulate the length of the slot. The amount of slot left uncovered when the note is in tune should never be less than the pipe's diameter. The width of the slot may vary from a fifth to a third of the diameter, the narrower slot being used for the smallest scales. Although some tone specialists are averse to slotting, there is really no musical objection to this device in the case of small-scaled pipes, for the reason explained under HORN DIAPASON. The unslotted viol pipe is less pungent and apt to be harder in tone; consequently, where power is required slotting is very desirable. Conical bells make a pleasing variation from the slot. There is an interesting example of a viola treated with adjustable bells at the Victoria College of Music, Holland Park Avenue, W. The scale is $2\frac{1}{2}$in. at CC, $1\frac{3}{4}$in. at tenor C, $1\frac{1}{16}$in. at middle C, with a two-ninths mouth cut up a third. The diameter of the bell at the top is one-and-a-half times that at the bottom. The bells start at AA♯ in the bottom octave and end at treble E, which is also the last rollered pipe. The un-belled pipes are not slotted. The wind pressure is 3in. This is, the author believes, the smallest scaled bell viola yet constructed; but the difficulty experienced in the tuning and regulation—which process necessitates the handling of the bells and thus heating the pipes—will effectually deter any but the glowing enthusiast from repeating the experiment.

Lastly, the upper lip of all viols without exception is bevelled to a sharp edge, and is convex to the mouth-line rather than concave, in order to facilitate the initial overblowing that precedes the application of the roller. After the cutting away of the ears, the promptitude of speech is perfected by a very careful depression of the languid, which is gently tapped down by a wooden rod inserted in the top of the pipe.

The 8ft. octave is often mitred at the top to allow room for these pipes in a swell box. Mitreing does not seem to injure the tone provided the return piece does not come too close to the mouth.

The 16ft. contra viola and the violin (sometimes called gambette) 4ft. are from the voicer's point of view merely octave extensions of the viola. The treatment of the 16ft. octave is given under VIOLONE. The contra viola is more often than not a tenor C double with a bourdon bass. Sometimes the bass is composed of an 8ft. viola and bourdon or quintaten, with the idea of creating a synthetic violone. The best arrangement is to provide a complete violone and borrow it on the pedal, and if it be enclosed in a swell box so much the better. Very small-scaled double viols are not popular with the modern organist: they are too reminiscent of the free reed of the pressure harmonium. Similarly, small-scaled violins (4ft.) are most nerve-racking stops. It was not so long ago that the violin was thought

the best type of 4ft. stop for the swell division. To-day, we have grown wiser, evincing a distinct preference for the geigen or violin principal, with its sufficient yet not extravagant harmonic development.

Viole Sourdine.—See MUTED VIOL.

Violin.—A 4ft. or octave viola (*q.v.*). The name is often applied to the 8ft. viol, but is best reserved for the octave stop.

Violin Diapason.—See DIAPASON.

Violoncello.—See VIOLA for the metal stop and VIOLONE for the wood stop.

Violone.—This is the 16ft. string stop of the organ, its upper register running into the violoncello. It is also called contra basso, double bass and violon d'orchestre. The 32ft. octave of the contra violone is not obtainable, except by synthetic (see ACOUSTIC BASS) or diaphonic treatment. The real article is a great asset to an organ, especially on the pedal. Only too often, however, a small-scaled diapason bass is labelled violone, and these are two distinct classes of tone, both entitled to a place in a complete pedal scheme, but not to be confounded. Violones of metal (spotted metal sometimes, zinc mostly) are found in a host of English organs, and very few can be regarded as even satisfactory. There are good examples at St. Saviour's Cathedral, Southwark, by Lewis, and at St. John's, Hammersmith, by Willis (1920). The scaling for the metal stop averages at 6in. at CCC (16ft.), the limits falling between 7in. and 5in. Mr. Compton has a 4in. scale violone at the Pavilion Cinema, Shepherd's Bush, which is an attempt (not unsuccessful) to carry down the scaling of the small-scaled viola ($2\frac{1}{2}$in., CC).

But the supremest type of violone is made of wood. Nor need one hesitate to make this statement who has heard the masterpieces of Schulze, Whiteley and Pendlebury. No metal example exists that can vie with these. The nearest approach is Mr. Compton's diaphonic violone. Schulze's pedal violone and great contra viola da gamba at St. Peter's, Hindley, are very famous examples of wood string voicing, and speak on low wind pressure. The scale of the pedal stop at CCC (16ft.) is $5\frac{1}{2}$in. square, mouth cut up $1\frac{7}{8}$in.; CC is $3\frac{3}{8}$in. square, cut up 1in. (the same as the CC pipe of the celebrated Armley violoncello); and tenor C is 2in. square, cut up $\frac{9}{16}$ in. The formation of the pipe is the same as that shown in Fig. B under DOUBLE DIAPASON, which is a sketch of the Armley wood diapason bass. To this the roller bridge must be added, which at Hindley is of unusual form, a portion of the interior at each end being scalloped out and leaving a small central projection. There is, however, no particular advantage in the fancy shape: it is merely one of interest. What is of importance is that the bridge should be so placed as to minimise the height of the mouth as far as possible. In a letter which Edmund Schulze wrote to Walker Joy dated April 28th, 1862 (a copy of which is in the author's possession), the following particulars are given as to the thickness of the planks required for the violone.

Schulze says: "The best thickness will be for the first halt octave one inch-and-a-quarter, for the next half octave one inch, from CC to GG three-quarters of an inch, and the rest half-an-inch." And in a postscript he adds, "The principal thing is to put a good cement inside the pipes." The last statement is both interesting and important. The use of cement is, of course, not essential, but the principle underlying its recommendation is not to be overlooked. It is that the interior of the planks of wood pipes should (like those of a swell box) be non-porous and non-absorbent. Sizing answers the purpose pretty well, but better still is hard-drying enamel or indestructible gloss paint. The block throat should be faced with mahogany or other hard wood, and the cap should be made of the same wood, the flue being polished with shellac and blackleaded. The slightest degree of absorbency in the materials forming the flue detracts from the excellence of the tone. Even the metal pipe is not immune from the adverse influences of molecular deterioration, the *languid* of old pipes frequently showing symptoms of absorbency followed in due course by porosity.

Schulze seemed to evince a preference for the square pipe, and for two reasons. First, he was thus enabled to reduce the unsupported width of plank to a minimum; and, secondly, the maximum width of mouth was thereby obtained without unduly sacrificing the pipe-area. It must be pointed out that the various mouth-widths of metal pipes have their counterpart in the wood pipe. A square pipe possesses a mouth that practically corresponds to a two-sevenths mouth in a cylindrical pipe. Thus by adopting the square formation Schulze was only transferring his favourite mouth-width from metal to wood. The Hindley contra viola (on the great) is a rectangular pipe, measuring at the 16ft. note $6\frac{1}{4}$in. by 5in., and this gives a mouth equivalent to the fourth mouth of a metal pipe: moreover, this is as it should be, as the 4ft. pipe and every pipe from this point upward is a metal one with a fourth mouth.[5] The rule to follow in this matter is to make the interior depth of the wooden pipe equal to the diameter of the corresponding cylindrical pipe, or conversely to assume the depth of the wooden pipe to be equal to the diameter of a metal pipe: then the width of the mouth of the wooden pipe is made the same as the mouth-width of the metal pipe. Thus, supposing we want to give a $6\frac{1}{4}$in. scale metal pipe a fifth mouth, we should make the mouth $3\frac{15}{16}$in. wide, and the wooden pipe scaled $6\frac{1}{4}$in. by $3\frac{15}{16}$in. would have the same relative width of mouth. Such a wood pipe as this would not be suitable, of course, for a violone, but it would make an excellent contra salicional.

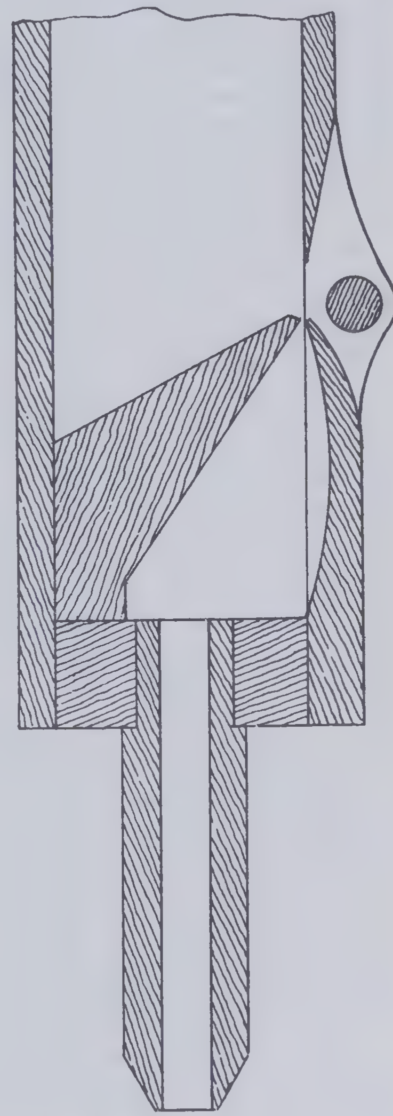
Reference to the above-mentioned illustration under DOUBLE DIAPASON must again be made when we examine the construction of the Pendlebury violone, violoncello and violin. The formation of the various parts of the pipe is fundamentally the same as shown at Fig. C of that sketch, the scale being reduced accordingly. The interior parabolic curve of the bridge is

[5] The scale of the 4ft. pipe is 2-3/16 in. These metal pipes are cut up as high as four-elevenths of the width and blown to the fullest capacity on $2\frac{7}{8}$in. pressure (without beards or bridges), in order to match the tone and power of the wooden portion of the stop (CCC to BB). The power and pungency of the bass and tenor register are but little less pronounced than the pedal violone, which is voiced on $3\frac{3}{4}$in. pressure.

peculiar to the type, the idea apparently being to intercept the emergent wind-stream more at the flue end of the mouth and to leave the upper part of the mouth relatively freer for the oscillation of the static waves. As has already been pointed out, all these devices are attributable to one main objective,—that of enabling the voicer to keep the mouth as low as possible. The bevelled top edge of the block imitates the languid bevel of the metal pipe, and since this bevel raises the top surface of the block above the level of the cap, nicking is required on the block. Mr. Pendlebury varnishes with shellac and blackleads all his flues.

The famous Pendlebury "violin" (which is really a viola) is of wood throughout the compass. In a swell box on a high pressure and with the tremulant, this stop creates a truly remarkable effect as a solo voice: in chords, especially above treble C, the effect is not so good, since the *timbre* is almost too positive. It is none the less a wonderful adjunct to the modern solo division. The scaling is as follows: CC (8ft.), 2in. square, cut up $\frac{5}{8}$in.; at ten. C (4ft.), $1\frac{3}{16}$in. cut up $\frac{3}{8}$in.; at mid. C (2ft.), $\frac{3}{4}$in., cut up $\frac{1}{4}$in.; at treb. C (1ft.), $\frac{1}{2}$in., cut up $\frac{3}{16}$in. The relative scaling increases at each octave,—namely, half on the sixteenth at ten. C, half on the eighteenth at mid. C, and half on the twentieth at treble C. An example on $3\frac{1}{2}$in. wind occurs in the swell division of the organ at the Wesleyan Church, Leigh, Lancs. Heavy pressure is preferable when available.

The last type of violone and violoncello we have to mention is that voiced by Mr. John W. Whiteley for the organ in the Battersea Polytechnic Institute in 1899. This stop has the advantage of heavy pressure (10in.). The pipe is illustrated in the accompanying diagram, in which, however, the top edge of the block is drawn to show a bevel, the Whiteley block-edge being flat at this point. Also the exterior of the cap is double-bevelled instead of rounded to allow



Whiteley Violone

the usual space for the mouth-stream. These are points of no importance, except that the Pendleburian block-bevel makes the construction absolutely modern, and enables the voicer to nick the block as well as the cap. As a rule, the cap is not nicked (Schulze never nicked any of his wood pipes on either cap or block), but the Whiteley pipe has an unnicked block and a nicked cap, the nicks being spaced at seven to the inch. The upper lip is splayed right across the plank of the pipe instead of being (according to usual practice) confined to the interior width of the front, and the cap is similarly formed. Metal ears are screwed on at the sides, and the roller-bridge is screwed to the ears just as one might do in the case of a metal pipe. The ears are cut-away above and below the bridge in the usual Whiteleyan manner. The planks are planed to half the thickness when the top of the pipe is reached: but there does not seem to be any justification for the extra labour involved, although all honour is due to those who make trial of these and such like experimental ideas. It would be interesting, we may venture to say *en passant*, to try a Vincent Willis double flue on one of these pipes, with suitable scaling and pressure. The scaling of the Battersea violone is as follows: CCC (16ft.), $6\frac{5}{8}$in. by $4\frac{1}{4}$in.; BBB, $4\frac{1}{4}$in. by 3in.; CC (8ft.), $4\frac{1}{8}$in. by $2\frac{7}{8}$in.; ten. C (4ft.), $2\frac{5}{8}$in. by $1\frac{11}{16}$in.; mid. C (2ft.), $1\frac{9}{16}$in. by 1in. The mouth is cut up a third of its width. This particular specimen is slotted, a process seldom carried out with wood pipes except for the purpose of tuning, and then the slot is cut from the top of the plank and not at a distance of the pipe's diameter from the top.

A study of these three types of wood string pipe construction will enable the reader to form a clear idea of the principles common to all types. The tendency at the present time is to omit the violone from the pedal organ, or to regard it as a luxury banned by the economic conditions bequeathed by the Great War. This is due to a false conception of tonal design, which would convert essentials into luxuries and *vice versâ*. Each one of the great tonal categories of the organ should surely find a place in the pedal scheme as in the scheme of any other division. An enclosed heavy pressure violone and 'cello could be assigned to the solo division and borrowed on the pedal, thereby making the most of the material without in the smallest degree sacrificing art on the altar of economy.

Voix Célestes.—When two 8ft. flue stops of soft tone are played together, one of them being tuned slightly flat or sharp to the other, this combination is known as the céleste. The earliest form of céleste consists of two dulcianas, which tuned to beat at a slow pulsation rate gave a pleasing effect. This type of céleste was in vogue for many years (often labelled "vox angelica") until the introduction of string tone of the *viol* type suggested the string or violes célestes. This again led to the provision on echo divisions of a *flute* céleste (labelled "unda maris") by way of effective contrast. Thus to-day we have three distinct types of céleste, which may be assigned to different sections of the organ, all being, of course, enclosed in suitable swell boxes: they are the flute, the dulciana or salicional, and the viol of various degrees of pungency.

A very beautiful example of the unda maris occurs in the echo division of the Norwich Cathedral organ by Norman & Beard (1889); and another at Christ Church, Lancaster Gate, W., by the same firm. The two ranks are in both cases composed of harmonic stopped (see ZAUBERFLÖTE) pipes. The unda maris on the choir at All Saints', St. John's Wood, consists of two ranks of fairly large-scaled dulcianas voiced in imitation of the dolce. It is essential that the beats should be slow, not only in the tenor and middle octaves, but also in the treble. That the "undulating" effect of the céleste may not degenerate into a wobbling dissonance, it is necessary to spend a little more time on fine tuning and regulation than is usually given to it.

The dulciana and salicional céleste has a modicum of string tone in its composition, and in some respects is the most beautiful type of all. For normal use, it is certainly the best; and where it is not possible to introduce more than one form of céleste in an organ, perhaps this one should be given the preference. There is an excellent example in the swell division of the organ in the Christian Science Church, Curzon Street, W., which is composed of a pair of slotted salicionals. Another variety could be formed of muted viols, but these would be only suited to the echo division.

The string céleste (or violes célestes) is formed of Thynne violas, and was first introduced by Thynne in the Michell & Thynne exhibition organ now in Tewkesbury Abbey. The original idea was to reproduce the effect of the orchestral divided strings, the pulsation of the slightly dissonant rank lending a "passion timbre" to the viola, which by itself it could never acquire. When Hope-Jones came on the scene with his tiny scaled viols, yet another chapter in the history of the céleste was written. The ethereal character of a céleste composed of two ranks of viols of $1\frac{1}{4}$in. scale at tenor C is quite indescribable. Such an effect is to be heard at Little Gaddesden Church. As a rule, however, the two ranks vary in scale from each other. At Great Gaddesden Church, for instance, the viola is $1\frac{3}{4}$in. at tenor C, while the céleste rank is $1\frac{1}{4}$in. Here we have in combination a Thynne and a Whiteley type, blending perfectly. Occasionally, the céleste comprises three ranks, one sharp and the other flat to a central rank which is tuned to pitch. An example occurs at St. Stephen's, Wandsworth, by Whiteley. The third rank, however, can only be considered a luxury.

Opinions are divided on the subject of the tuning of the céleste. Some are in favour of the dissonant rank being flat, others would have it sharp to pitch. Thomas Casson preferred to make both ranks deviate from the central pitch, thus distributing the intentional error evenly. The objection to the latter device is that it necessitates a third rank, tuned to pitch, if it is required to use the same tone-colour apart from the céleste effect, so that we get back to the three ranks once more. The difference between a flat and a sharp céleste is theoretically non-existent *per se*, since it is merely to reverse the position of the two ranks. The flat céleste rank of an organ tuned to the new Philharmonic pitch would become the in-tune rank of the Society of Arts pitch, while the in-tune rank of the former would in its turn become the flat rank of the latter. In short, both ranks are sharp or flat according to their relative positions to each other. The only point that can be adduced

in favour of the flat rank is that mentioned to the author by the gifted blind organist and composer, Mr. W. Wolstenholme: namely, that in the sudden introduction of a flat rank the deviation from central pitch is not so noticeable as in the case of the sharp rank; but as the other great blind organist, Dr. Alfred Hollins, has expressed his preference for the sharp rank, it seems quite impossible to dogmatise on this point until the doctors can find some substantial basis of agreement. The precise degree of deviation from pitch is a matter of far greater importance, for this determines the rate of pulsation. The string céleste is of a more passionate nature than the other types, which should be of a calm, floating character. Consequently, a relatively quicker beat is allowable for the former. But the relative difference in speed should be small. Supposing the correct pulsation-number at middle C for the dulciana céleste to be 144 per minute, that for the string type would be 216 at the highest computation, and these are fairly accurate figures for the tuner's guidance, as they provide him with a safe minimum and maximum for all types. A well-trained ear never errs in these little points. There is also a tendency to make the beats too rapid in the treble portion of the compass. This is due to the desire to supply the organist with a playable stop when the out-of-tune rank is separately drawn. With this object in view it is considered a virtue to lay the bearings on *both* the ranks, and then to tune the octaves up and down to the middle octave in each case. This method of tuning is bound to leave the treble in a highly unsatisfactory state when the two ranks are played together. Nature demands that the vibration-numbers of each note shall increase during the ascent of the pitch, so that either the lower register will be too slow or else the upper too rapid. The only satisfactory method of tuning is to lay the bearings on the in-tune rank and tune it as a principal; then to draw the céleste rank with it and tune from tenor C to top note by note, preserving the pulsation-number fairly evenly throughout the series. Then run over the complete stop a second time, picking out any errors and putting in the finishing touches. The céleste rank will be found to be out-of-tune with itself, but the effect of the célestes will be perfect. Let us be fair to the artistic side of the question and make up our minds to sacrifice the problematical value of the separated dissonant rank to the far greater claim of the célestes as an artistic adjunct to the organ.

The compass of the céleste usually extends from tenor C to top note, but some builders prefer to carry it a little further down, say to AA or GG. The extended compass is only needed for the string type. Some architects are in favour of the 4ft. or octave céleste as a complement to the 8ft. effect. There is, of course, no objection to this, but the octave coupler produces all that is required. A pedal céleste is an absurdity unless it be the solo 'cello céleste duplicated on the pedal. The effect of sub and octave couplers on the céleste is well known, the string type being considerably enhanced thereby. An appropriately voiced vox humana added to this combination often serves as a very fair recipe for orchestral strings, and a very smoothly voiced clarinet will sometimes introduce the "body" that the organ viol can never hope to possess in comparison with its prototype. Obviously all these stops should be enclosed.

With regard to the position of the céleste ranks on the soundboard, it is imperative that they should be sufficiently separated from each other to prevent "sympathetic interference" on the part of their respective sound-waves. At least, one rank of pipes should stand on the soundboard between the two céleste ranks; but if two or three stops are allowed to intervene all troubles with overlapping sound-waves can be avoided.

The idea that the two ranks forming the célestes should be markedly differentiated in tone and power is now exploded. A small margin for differences of *timbre* is permissible, but the quality should belong to the same tonal category: flute with flute, dulciana with dulciana, string with string. Even exact duplication is preferable to undue differentiation. The relative strengths of the ranks also should be carefully controlled: it is fatal to make the dissonant rank about half the power of that of the in-tune stop. If the former is regulated to a strength relatively three-quarters of the strength of the central rank, this is as soft as one need ever make it. As a rule, the power should be the same for each rank.

The number of purists who condemn the céleste as "a gross libel on the harmony of the spheres" is fast dwindling. Behind this special contrivance, which at first sight would seem to be "a miserable fake," lies a great truth. That truth is that there is no real harmony without life. There is the harmony of the stagnant pool, and the harmony of the restless sea. There is the harmony of the forest scene in mid-winter, and the harmony of that same scene when the leaves are rustling in the summer breezes. Ask any student of nature which is the harmony he prefers. It is the harmony of *life*. Therefore, why should we give ear to those whose one idea is to rob organ tone of its natural buoyancy and *joie de vivre?* The céleste has won its way to almost universal acceptance through sheer merit. In all questions of this kind, the ear is the only arbiter.

Vox Angelica.—See VOIX CÉLESTES. This name is occasionally applied to a small-scaled dulciana, and in Germany it is a type of vox humana. There seems little justification for its continuance.

Vox Humana.—16ft. and 8ft. As the name implies, this is an attempt to imitate the human voice, and much as the egoistic pedant may sneer at the vox humana, *et hoc genus omne*, the fact remains that not only can the highest artistic use be made of this stop, but the resemblance to the human voice can be effected much more closely than ignoramuses who know less than nothing about voicing would allow us to believe. Familiarly speaking, this is nothing more than a clarinet pipe cut down to two-thirds, half, or a quarter, according to the type of tone required; indeed, the author has himself actually converted a clarinet into a vox humana by cutting down the tubes and adjusting the tongue curvature and tuning length to accord with the shorter tube. This example is to be heard at Great Gaddesden Church, near Hemel Hempstead. The majority of vox humanas have only eighth-length tubes and are capped at the top with slots cut below. This is *not* the way to get the best result. Moreover, the absurdly short tube exercises so little control over the tongue that such a pipe is

thrown out of tune at the slightest change of temperature. The tone of the vox humana should be distinctly inclined to *flutiness*, especially from middle C up. The two top octaves should be made harmonic or double length,—that is, clarinets. The scaling is usually that of the clarinet, but is best a pipe or two larger. The following is an excellent scale:—

CC	(8ft.)	$1\frac{3}{4}$ in.	...	tube-length		$11\frac{1}{2}$ in., $26\frac{1}{2}$ in., $34\frac{1}{2}$ in.
Ten. C	(4ft.)	$1\frac{7}{16}$ in.	...	,,	,,	$8\frac{1}{2}$ in., $13\frac{1}{2}$ in., 17 in.
Mid. C	(2ft.)	$1\frac{1}{4}$ in.	...	,,	,,	$6\frac{5}{16}$ in., $8\frac{7}{8}$ in.
Treb. C	(1ft.)	$1\frac{3}{16}$ in.	...	,,	,,	$3\frac{5}{8}$ in., $4\frac{3}{4}$ in.
C in alt.	(6in.)	$1\frac{1}{16}$ in.	...	,,	,,	$3\frac{9}{16}$ in. (half-length)

Adjustable oboe shades should be fitted to the tops of the tubes, and when the stop is regulated and tuned, these shades (or half-caps) ought to leave quite a small portion of the tubes open. The shallot is exactly the same as that used for the clarinet, the opening being cut a fourth of the shallot's length. The boot-holes are quite small, the tongues being only slightly curved. Heavy pressure is not essential.

The Cavaillé-Coll examples are always excellent. If anyone is anxious to know what a really good vox humana can be made to sound like, let him go to Great Brickhill Church, near Bletchley, where an organ of great beauty possesses among its stops a Cavaillé-Coll imitation of the human voice. Another specimen by this builder can be heard at St. John Baptist's, Holland Road, fitted with domed caps.

The 16ft. vox humana is sometimes called "baritone," but it is not a very useful stop, as the double effect can be obtained from the suboctave coupler, and the 16ft. octave is not wanted.

The vox humana is greatly benefitted by a remote position, but there is no necessity whatever to isolate it from the rest of the organ or to give it the privilege of special enclosure. It is chiefly of service in combination with other orchestral tones, and therefore should be grouped with them in the same swell box. Its capacity as a *timbre*-creator was fully recognised by Mr. E. H. Lemare many years ago, and to-day every great performer uses it for colouring matter. By playing *staccato* chords on the 8ft. harmonic flute and the vox humana with the box closed, it is possible to secure a very striking imitation of a *pizzicato* passage on the muted strings. The addition of the vox humana to the string célestes, with octave couplers, is a well-known method of copying the effect of the orchestral strings. The combination of the vox humana with the 4ft. orchestral flute and the suboctave coupler (with or without tremulant) provides also another very orchestral effect. Add the vox humana and octave coupler to the 16ft. and 8ft. oboes and often one can imagine the presence of an echo mixture. In short, the possibilities are immense.

A great deal of time and ingenuity has been expended on the formation of the different vowel sounds by fitting resonators of varying shapes to the

vox humana pipe, but the idea has been abandoned as not worth the trouble. Success in this direction has been attained by Kratzenstein, Kempelin and Willis of Cambridge; and in the domain of scientific research the results are highly interesting and instructive, but are nevertheless of little real value in the evolution of organ tone and design.

Waldflöte.—8ft. and 4ft. This name represents the wooden flute pipe whose mouth is inverted on the narrow side of the pipe, with a sunk block as shown on page 40. If the inverted mouth be formed on the wide side or on a square or triangular pipe, the stop is then a species of hohlflöte (*q.v.*). The waldflöte is a speciality of Messrs. Walker, and has occupied the position of the great organ flute in practically every instrument built by that eminent firm during the past half-century. The Father Willis choir 8ft. flute was frequently a waldflöte, though labelled "hohlflöte." Its scale was $1\frac{3}{4}$in. by $1\frac{3}{8}$in. at 2ft. C. The scaling of the Walker waldflöte[6] is as follows: mid. C, 2ft., $1\frac{5}{8}$in. by $1\frac{1}{2}$in., cut up $\frac{5}{8}$in., eleven nicks on block and cap; treble C, 1ft., 1in. by $\frac{7}{8}$in., cut up $\frac{5}{16}$in., ten nicks; C in alt., 6in., $\frac{11}{16}$in. by $\frac{9}{16}$in., cut up $\frac{1}{4}$in., nine nicks. These measurements are taken from the beautiful specimen at New College Chapel, Hampstead, N.W., where the wind pressure is $3\frac{3}{4}$in. The lowest twenty-four pipes are stopped. The break between open and stopped pipes is better made lower down,—say at tenor F. Many examples exist in which the open pipes are carried down to GG. The *timbre* of the inverted mouth flute is quite peculiar to the type, and while no doubt can be entertained as to its beauty yet it is apt to pall on the ear more quickly than the splayed mouth clarabella. This is due to the prominence of the octave or first upper partial and not, as some authorities have supposed, to the septime. The inverted formation of the upper lip favours the octave, while the inverted formation of the lower lip favours the fundamental. This fact was evidently realised by W. E. Haskell, who has adopted this formation of mouth in all his orchestral imitative productions, —such as the oboe, saxophone and tuba. The saxophone is described under that heading. Another peculiarity of the inverted mouth is the orchestral "lip" effect it imparts to the speech of the pipe. The travers flute of the orchestra has its *embouchure* formed on a similar principle, the wind from the player's mouth being directed obliquely across it. So, too, the wind from the flue of the organ inverted mouth wood pipe is directed obliquely against the upper lip. The waldflöte is used in America under the name melodia. Messrs. Walker have frequently adopted the 16ft. stop for their great double diapason. The 4ft. stop is a very pretty flute for the choir division, and is often labelled suabe flute. There is a singularly fine example by Hill (1879) on the unenclosed choir at Great Brickhill Church, near Bletchley (see under SUABE FLUTE). A stop of this kind does not seem suitable for the great, in which department flute tone should be introduced with caution (see FLÛTE OUVERTE). It is the opinion of some that the waldflöte gives the best imitation of the orchestral horn. This is to leave a great deal too much to the imagination, for (with the possible exception of

[6] The Walker specimen at Fulham Parish Church, however, measures $1\frac{3}{4}$in. by $1\frac{1}{2}$in. at mid. C.

the tenor octave of the waldflöte combined with a smooth soft reed) there is very little real horn *timbre* in the flute stop. One has only to get a horn player to alternate his notes with those of the organ stop to see how slender the resemblance is in actual fact. The nearest approach (as far as it is yet possible to go) to horn tone is to be obtained from reed pipes and not from flue (see FRENCH HORN).

Waldhorn.—16ft. and 8ft. This is the corno di caccia, or hunting horn, of olden times. We have already (under HORN) pointed out the undesirability of imitating the strident tone of such an instrument. The firm of Willis & Lewis usually so designate their swell double reed, the tone and finish of which leaves (as one might expect) nothing to be desired, since it is the ideal type for such a stop. It belongs to the normal category of chorus reed tone (see under TRUMPET), the bass and tenor octaves being beautifully smooth and round.

Zartflöte.—8ft. and 4ft. A delicate flute tone, as its name implies. Schulze introduced into his echo division at Armley a small scaled gemshorn of 8ft. pitch under this title. It is almost exactly the same as the "fernflöte" by the same voicer on the choir at St. Mary's, Tyne Dock. The bass is of wood. The name is also employed by Messrs. Brindley & Co. for their choir 4ft. flute.

The zartflöte of Whiteley is a small-scaled quintaten, being introduced in 1896 under the name of "phoneuma" in a number of Hope-Jones organs. Familiarly speaking, it is a stopped viol pipe, the prime and twelfth sounding simultaneously at equal strength. The tone is very delicate and quite soft, is suited for the echo division only, and thus is somewhat of a luxury. The scale at 2ft. C (4ft. ground tone) is 1¼in. with a two-elevenths mouth. If the stopper be removed the pipe becomes a viol, and the voicing is done before the stopper is fitted. The roller-bridge is fixed at a greater distance from the mouth than is usual in viol treatment, and with this end in view the ears are made relatively longer.

Zauberflöte.—8ft. and 4ft. This name was first used by Michell & Thynne for a flute stop of 4ft. pitch, which they placed in the unenclosed choir division of their celebrated Inventions Exhibition organ of 1885, now in Tewkesbury Abbey. From tenor C to top, the pipes are stopped, three times the normal length, and overblown to speak the twelfth. Wood is used from tenor C to E (five notes), and the remainder of the stop from tenor F is of metal. The scale of the tenor C pipe is 2¾in. by 2⅛in., its length being 33½in. from the block. A node-hole, $\frac{1}{16}$in. in diameter, is pierced at a distance of nine-sixteenths of the speaking length of the pipe from the upper lip. The scale of the mid. C note (treb. C note) is 1$\frac{15}{16}$in., its length being 16¾in. from the upper lip, with the node-hole in the same relative position. The mouth is two-ninths in width, and cut up a fourth of its width. Similar examples exist at St. John's, Richmond, Mr. J. Martin White's chamber organ at Balruddery, near Dundee, and Holy Trinity, Upper Tooting. The tone of

these stops is clear and liquid. As early as 1754, however, Snetzler had introduced an 8ft. harmonic rohrflöte into his organ at St. Margaret's, King's Lynn, under the name of German flute; and Messrs. Norman & Beard reproduced the effect of this stop in their organs at St. Catherine's College, Cambridge (labelled "harmonic gedackt 4ft.") and at Norwich Cathedral. The original Snetzler pipe was of the usual chimney pattern, the scale at middle C being 1¾in. (giving 2ft. tone). Ordinary stopped pipes were used for the lowest twenty-four notes. At the present time, Messrs. Rushworth & Dreaper are introducing a powerful wooden example on heavy pressure, labelled "flûte bouchée harmonique." There is a remarkably fine 4ft. specimen in the solo division of the Westminster Chapel organ, Buckingham Gate, S.W., on 8in. wind. This instrument also contains a 4ft. zauberflöte of metal, which is much softer. In the concert organ built by this firm for King George's Hall, Blackburn, there is an 8ft. zauberflöte in the enclosed choir division on 4in. wind, a flûte bouchée harmonique 4ft., and a zauberpiccolo 2ft. on the enclosed solo division on 6in. The stopped harmonic pipe is also regarded with favour by some tone specialists for the production of artificial mutation ranks, especially the twelfth. In the constitution of a *timbre*-creating apparatus, the zauberflöte would doubtless prove a valuable tone quality, owing to its freedom from overtones; but its triple length necessarily increases the cost of production. The author possesses a sample wooden zauberflöte middle C pipe fitted with the Vincent Willis double flue, but the tone is no better than the best examples constructed in the normal manner.

Glossary of Technical Terms

Glossary of Technical Terms

RELATING TO THE SCIENCE OF TONE-PRODUCTION FROM ORGAN PIPES

(*Compiled with special reference to the text*)

AIR - REED.—The sheet of wind or wave-front which emerges from the flue of a pipe and vibrates at the mouth, thus causing the pipe to speak. The vibrations of this air-reed are called "static waves." The vibratory motion is due to the fact that the wave-front is drawn into the mouth of the pipe by interior suction and then expelled, this reciprocal process repeating itself in rapid succession. The action is that of an invisible free reed.

AMPLITUDE.—Extent. *Amplitude of vibrations:* the maximum displacement of a vibrating body or particle from a position of rest; thus, to increase the amplitude of the vibrations of a reed tongue or of the stream of wind emerging from the flue of a pipe means in either case to increase the extent of the pendular swing. This is to increase the power or intensity of a note.

ARCHED.—Curved so as to make the centre the highest point. The upper lip of a flue pipe is sometimes cut to this special shape, the idea being that the depression at each side of the lip prevents unsteadiness and wastefulness in the sheet of wind as it vibrates at the mouth.

AREA OF DISCHARGE.—The quantity (in cubic inches) of pressure-wind flowing through a given orifice, such as the foot-hole of an organ pipe.

ATTACK.—The first speech of a pipe, so called because the sudden charge of the released pressure-wind from the soundboard to the pipe affects the initial speech variously in accordance with its velocity.

BAR.—A flat piece of metal or wood placed horizontally in front of the mouth of a flue pipe and held in position by the ears. The object of this device is to prevent the pipe from flying off its normal speech to its octave or twelfth. It is most effectively placed in an oblique position, that is at an acute angle to the mouth-line. (See BEARD and BRIDGE.)

BEARD.—A similar contrivance to the bar (*q.v.*), but strictly differentiated by the fact that it is placed *under* the ears of the pipe like a fender. Its office is to ensure promptitude in the speech of a pipe without unsteadiness.

BEATING REED.—There are two kinds of reed pipe; the free reed, in which the tongue is made to vibrate freely *through* the opening in the reed or shallot; the beating reed, in which the vibrating tongue *beats against* the opening and alternately covers and uncovers it. The latter is also called a "striking reed."

BELL.—An inverted truncated cone, fixed (usually soldered) to the top of an organ pipe. See illustration on p 45.

BEVELLED. — Having an edge cut to an angle other than a right angle. Thus, the languid of a metal flue pipe has a bevelled edge on which the nicks are cut. The blocks and caps of wooden pipes are often bevelled in various directions.

BLOCK.—(1) That part of the wooden flue pipe which corresponds to the languid of the metal pipe. It divides the speaking body of the pipe from its foot, and its front edge forms part of the flue and wind-way, the cap forming the other part. See diagram of wood pipe on p. 99, where the block is marked *(a)*. (2) That part of the reed pipe which separates the tube from the shallot. See diagram of reed pipe on p. 66, where the block is shaded.

BODY OF PIPE.—The upper portion of all pipes, being the speaking length of a flue pipe, and the tube of a reed pipe.

BODY OF TONE.—Tonal massiveness and foundation.

BONNET.—A term occasionally used for the hood of a reed tube, formed by being knuckled over at the top. (See HOOD.)

BOOT.—The metal covering fitted like a boot to the block of a reed pipe so as to form a pressure chamber for the sound-apparatus. See diagram of reed pipe (on p. 66), where the boot is marked *(g)*.

BORE.—The foot-hole of a pipe.

BREAK.—The junction between two types of tone-production or two registers, as for instance when a stop consisting of open metal flue pipes is continued down by a stopped wood bass. Also in a mixture stop, when the pitch of one or more of the ranks comprising the mixture is at a certain part of the compass changed to the octave below or to some other pitch. A good illustration of this is seen in the old-fashioned "campana, 1 ft.," which repeated the lowest twelve notes at each successive octave, and was said to "break back an octave at the C's."

BRIDGE.—The most modern form of bar, being cylindrical or semi-cylindrical in shape and used in the voicing of pipes of the viol or string class. Its application is the same as that of the bar (*q.v.*). Also called "roller-bridge," and (by Audsley) "harmonic-bridge." See also p. 74, where the function of the bridge is explained.

CANISTER.—A metal stopper, in appearance like a small inverted mustard tin or tea canister, fitted to the top of a metal flue pipe in place of the more usual wooden stopper, and adjustable like the tin tuning slide.

CAP.—(1) A circular metal lid soldered to the top of a reed pipe. If the cap completely covers the top, a slot is cut just below so as to provide an opening at the side; otherwise the pipe would not speak. The cap may, however, be left free at one end, and is then called a "half-cap" or "shade." (2) The removable face-cover of the wooden pipe, which with the block forms the flue and wind-way. See diagram of wood pipe on p. 99, where the cap is marked *(b)*. (3) The small brass plate which fills in the head of a reed shallot, thus removing the base to a point further up the shallot and providing a pocket inside the head. See illustration B of reed shallot on p. 66.

CHORUS.—A complete tonal design or structure composed of a family of stops of the same class, such as the diapason chorus or the reed chorus.

CLOSED SHALLOT.—The form shown in illustration D on p. 66, of a reed shallot, where the opening is V-shaped. (See SHALLOT.)

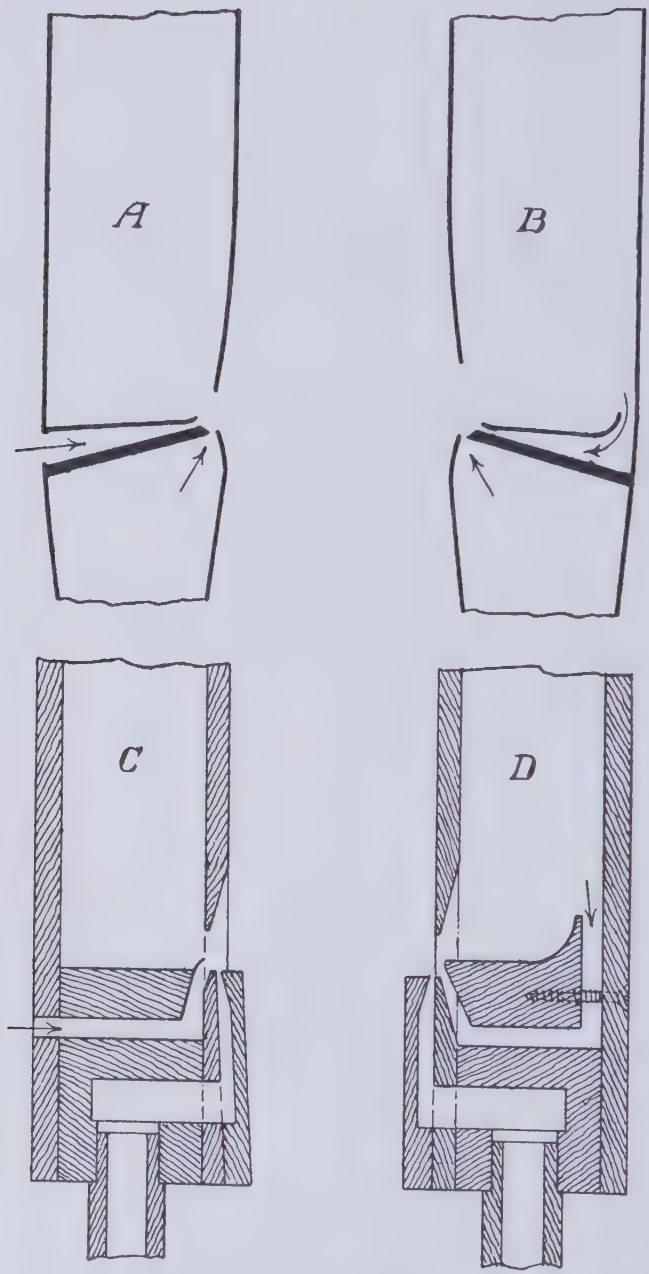
CLOSE TONE.—An expression applied to a reed when it is voiced to produce a comparatively dull, smooth tone lacking harmonic development. The word "close" refers primarily to the closeness of the tuning-spring to the point on the tongue at which the note flies off to a harmonic, usually a major or minor third. (See also FREE TONE.)

CLOTHED FLUE.—Lined with split-skin. (See LEATHERED LIP.)

COLOUR.—The precise quality of tone produced by an organ pipe. Synonymous with *timbre*.

CONICAL.—Circular in form, but narrower at the top than at the bottom,—i.e., tapering.

CONSONANCE.—Agreeing together; harmony between two or more sets of vibrations, as when two or more speaking pipes are in tune with each other. The *consonance* of the tube and tongue of a reed pipe means that the air-column in the tube vibrates in accord with the pitch-vibration of the tongue. This consonance does not depend on the exact coincidence of the two, there being a definite period or margin for deviation before dissonance is created. What is necessary is that the natural period of vibration of the tongue should stand in a proper ratio to that of the tube. During speech a series of condensations and rarefactions take place in the air-column proceeding from the closed end of the shallot and shaping a node *at the point where the tips of the tube and shallot meet* (hence the importance of scaling this latter properly). The relation between the tube and the tongue is called by voicers the "control;" if the tube is too long, it causes the note to "choke" and then fly off to a harmonic, and the note is said to be "over-controlled;" if the tube is too short, the note is harsh and unmusical, that is, "uncontrolled" or "too free." The object of the voicer, therefore, is to secure the



Double Languid Pipes (Vinçent Willis)

happy mean between these two extremes, thus producing a note that is neither too close nor too free, even though it may not be necessary to exclude deviations from the normal.

CURVE.—(1) The arc of gyration given to a reed tongue *(q.v.)*. (2) The inward,—i.e., mouthward formation of the lower lip of a flue pipe.

CUT UP.—The height of the mouth of a flue pipe, so called because the mouth is made purposely low for the voicer to cut up to the required height.

DIAPASON.—The standard flue tone of the organ, being the class of tone in which the development of upper partials or overtones is normally balanced between flute and string.

DISCHARGE.—The flowing of pressure-wind through a given orifice, such as a soundboard pallet-hole or the foot-hole of a pipe.

DISSONANCE.—Disagreement between two or more notes, due to antagonistic vibrations.

DIVISION.—A tonal section or department complete in itself, such as the great, swell, choir, echo, solo and orchestral divisions.

DOUBLE-LANGUID: DOUBLE-FLUE.—An upper languid or plate fitted over the ordinary languid of a metal flue pipe leaving a narrow space between, thus creating a second flue, called the "false flue." In the wooden pipe the second flue is produced by fitting an upper block over an ordinary sunk block, leaving a narrow channel between. See diagrams on p. 94.

DUBBED LIP.—A special type of flatting applied to the lower lip of a metal flue pipe, and introduced by Willis. The peculiarity consists in the "punching" or "dubbing" (*dub* being Anglo-Saxon for "strike") of the *top* part of the lower lip so as to make it curve toward the languid and create a convergent flue. In a 2ft. pipe the dub-curve would be formed at a distance of about $\frac{3}{16}$in. below the top surface of the lip. The effect of the formation is to increase the amplitude and frequency of the static waves at the mouth of the pipe, as well as the quantity of wind discharged at the flue; hence it is mainly employed for the larger scaled pipes and for the production of power. There are three distinct types of flatting for the lower lip, evolved in this order: the early English or vertical, the Schulze or moderately curved, and the Willis or dubbed. All three have their uses in the modern organ and are invaluable for the various types of stop that each more particularly suits. The early English flatting is only suitable for light pressure diapasons and echo flutes; the Schulze is the normal type for all metal flue stops, and is specially indicated for diapasons and strings; the dubbed lip is of great value in the treatment of high pressure flue-work generally and of the flute category.

EARS.—The projections fixed to the sides of the mouth of a flue pipe. Their office is to shade the mouth and control the wind-stream. Ears are not required for very small pipes, except those which are voiced for string tone.

EFFECTIVE PRESSURE.—The actual pressure of wind in the foot or boot of an organ pipe which is used by the voicer in his treatment of the pipe. Also called "speaking pressure," "foot pressure," "settling pressure."

ENCLOSED.—Refers to pipes planted in a swell box, and thus rendered comparatively remote and susceptible to the *crescendo* and *diminuendo* effects of the shutters. Pipes intended for enclosure are voiced to suit that position.

FELT WEIGHT.—A pad of felt glued on to the end of a reed tongue in order to slow down its vibrations under wind pressure. When felt is not of sufficient weight, a small piece of lead is glued to the top surface of the felt. (See WEIGHT.)

FILLED IN SHALLOT.—See SHALLOT; also CAP (3).

FLAT.—An error in the curvature of the reed tongue. When the tongue is held down in the position of covering the opening of the shallot, no light should be visible between the tongue and the shallot. Light seen at any point proves the existence of a "flat" in the tongue, which must be removed (either the flat or the tongue).

FLATTING.—The formation of the upper and lower lips of a metal flue pipe.

FLUE.—The narrow slit or fissure between the lower lip and the languid-edge of a metal pipe, or between the top edge of the cap and the block of a wooden pipe. Also called the "wind-way." It is rightly called the *flue*, because the wind *flows* through it into the atmosphere. See WIND-WAY.

FLUE PIPE.—A collective name for those organ pipes, metal and wood, whose speech is dependent on the flowing of pressure-wind through a flue setting up vibratory waves *from this point*. As such it is distinguished from the other great class of organ pipes in which the note is produced by a vibrating tongue of brass controlling periodic wind-impulses at the orifice of a *reed* or shallot. The different parts of a metal and wood flue pipe are shown in the diagrams on pages 18 and 99 respectively.

FLUTE.—The class of flue tone in which the development of upper partials or overtones is restrained to the point of dullness.

FLUTY.—Possessing the characteristic tone of the flute class.

FOOT.—The lower portion of a flue pipe through which the wind is admitted to the flue. See diagram on p. 18 where the foot is marked *(c)*.

FOOT PRESSURE.—See EFFECTIVE PRESSURE.

FOUNDATION TONE.—The mass or body of 16ft. and 8ft. flue and reed tone which forms the basis or foundation of the complete chorus. In obsolete phraseology the term "foundation tone" referred to all those stops which speak the unison or any of its octaves in contra-distinction to mutation tone. This is to confuse the basis with the structure built upon it. The real distinction is between the foundation and the upper work. The expres-

sion "foundation tone" is also applied to diapason tone, and then denotes weight and dignity as opposed to undue string development.

FREE TONE.—An expression applied to a reed when it is voiced to produce a fiery tone with ample harmonic development. It is then *free* from the danger of flying off to a harmonic. (See CONSONANCE.)

FREE REED.—See BEATING REED.

FREIN HARMONIQUE.—The original bridge of metal employed for string stops. It is attached to a spring and adjustable. The order of evolution is thus: (1) beard, (2) bar, (3) frein, (4) roller-bridge.

HALF MEASURE.—This refers to the relative scaling of organ pipes. Every pipe in the organ has its own scale or diameter, and in a stop of pipes the relative sizes of the pipes from the largest to the smallest are graded in ratio. Given the length and diameter of the tenor C (4ft.) pipe, at what point in the scale above this note is the length and diameter to be halved? That is the question. The half length will fall on a note relatively lower in the scale than will the half diameter. As a rule, unless the diameters of the pipes are very small, the half length is reached before the octave or twelfth note above; but the half diameter is delayed till after the octave above is passed, on the sixteenth note above at the lowest, and even as late as the thirty-eighth note in the progressive scaling of reed pipes. The object of this is to prevent the pipes diminishing in size too rapidly during the ascent of the compass. The scale is then said to "halve on the sixteenth, or the thirty-eighth," as the case may be. In short, the scaling of organ pipes follows a regular geometrical progression, the ratio of diminution being determined by the note on which the half measure is to fall.

HALF STOPPED.—Having a hole pierced through the stopper.

HARMONIC.—(1) A constituent element of a musical note, which consists of a prime tone (determining the pitch) and certain defined overtones or upper partials, such as the octave, twelfth, superoctave, &c. These are called "harmonics" or "partial tones." When the harmonics of a musical note are well developed, so that the series is carried up to the eighth partial or even higher, the result is a pungent or reedy quality of tone; when, on the other hand, the harmonic development is restrained, a dull, fluty tone results. Between these two extremes exists a *via media*, to which the standard foundation of the organ tone conforms. (2) A term applied to an open flue pipe when the speaking body is made double its normal length, and the pipe overblown to speak the octave or first upper partial: or to a stopped flue pipe when it is made three times its normal length and overblown to speak its twelfth. A reed pipe also is said to be "harmonic" when the tube is made double its normal length and the tongue is tuned to give the same note as if the tube were of normal length. Thus, middle C is normally produced from a reed pipe approximately 2ft. long; but if the tube be lengthened to 4ft. (or double the normal middle C length) and the tongue be tuned to sound middle C instead of tenor C, the pipe is said to be harmonic.

HARMONICS.—See HARMONIC (1).

HEAD OF SHALLOT.—The closed end or base of the reed shallot, which is wider than the "tip" or other end.

HEAD OF TONGUE.—The wide end of the reed tongue; the end where the curve is greatest. The other end is called the "tip."

HEAVY PRESSURE: HIGH PRESSURE.—The force or pressure of wind supplied from the reservoir to the soundboard and ultimately to the pipes is measured by the anemometer or wind-gauge, which registers the degree of pressure in inches (the difference between the two water levels). When the pressure measures more than 4in., it is said to be high or heavy, though the line of demarcation between high and low has not yet been universally fixed. Anything under 4in. is by common consent regarded as "low" pressure, while some authorities call 4in. to 5in. a "medium" pressure, and all pressures above 5in. "high." In this work the dividing line is placed at 4in.

HOLLOW TONE.—The epithet "hollow" as applied to organ tone is somewhat loosely used by connoisseurs. It is, for example, difficult to justify its application to the tone of an open flute (hohlflöte). What, precisely, is "hollow tone?" Familiarly speaking, it is the deep, resonant note produced by tapping the external walls of a cavity, but as all organ pipes possess an internal cavity, this connotation would only seem to cover a small part of the ground. All expressions descriptive of *timbre* should be compatible with definite scientific principles, and this can only be so when they are based upon the analysable condition of the harmonic series. It may be supposed, therefore, that the presence of both the odd and even series of harmonics in combination, whatever the degree of their development, constitutes "solidity" of tone; while the suppression of a given series through creating an "internal cavity," induces "hollowness." Proceeding upon this assumption, we may with some justification apply the term "hollow" to the tone of stopped flue pipes and cylindrical-bodied reed pipes (and possibly to certain types of capped reed), but the tone of open flue pipes and of reed pipes with conical resonators would be classified as "solid" or "compact."

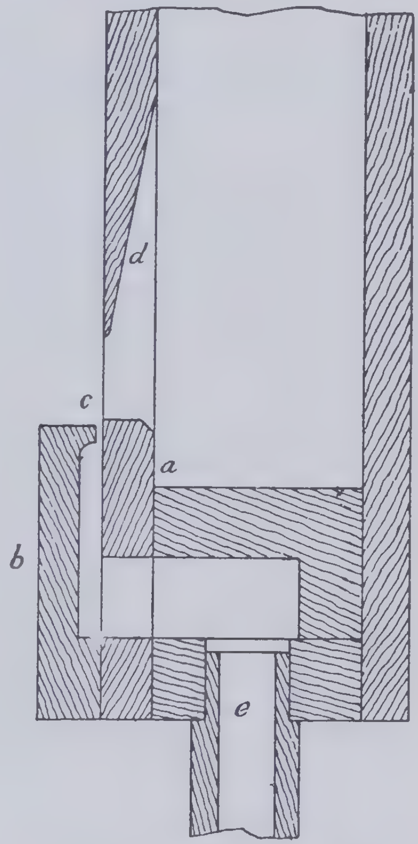
HOOD.—The tops of reed tubes are frequently elbowed over at right angles in order to prevent dust and dirt falling down the pipes. These projections are called "hoods," and the process "hooding." Hooding is not so necessary when the pipes are enclosed in a swell box. Hooding is sometimes adopted with the additional object of directing the sound-waves of powerful trumpets or tubas towards the auditorium or away from the roof of the building. The same object is achieved by bending the tubes at an obtuse angle at a point not far removed from the "tip," a process known as "fan-mitreing." There is an example of a "fan tuba" at York Minster by Messrs. Harrison & Harrison.

INDUCED DRAUGHT.—The draught of air which is introduced at the mouth of a flue pipe through the false flue of a double-languid formation, thus increasing the amplitude and velocity of the vibrating wave-stream or

air-reed. (See DOUBLE-LANGUID.) Vincent Willis, the inventor of this form of flue pipe, claims that the velocity of the vibrating air-column in the pipe-body is accelerated thereby.

INVERTED LANGUID.—A metal pipe languid placed upside down. The top suface of the languid is then flush with the top edge of the lower lip and is not nicked. See diagram of this type of languid on p. 18.

INVERTED MOUTH.—When the upper and lower lips of a wood pipe are turned inwards instead of facing outwards, the mouth is known as "inverted." Ordinarily the upper lip is splayed or bevelled outside the pipe, but when inverted it is bevelled inside, the face remaining level. The lower lip also is formed by a sunk block, the flue being cut from the cap which is set outside the upper lip line. The whole formation is imitative of the *embouchure* of the travers flute. See the accompanying illustration. It is not necessary to invert both upper and lower lips, and often the mouth is said to be inverted when only the upper lip is so treated. Strictly the term implies that the lower lip is inverted as well, and if only one of the lips is inverted the word "lip" should be used, and not "mouth."



WOOD PIPE WITH INVERTED MOUTH

a. Sunk block
b. Cap
c. Flue
d. Upper lip
e. Foot

LANGUID. — The flat, horizontal plate of lead alloy which separates the foot of a metal flue pipe from its body. The front edge is bevelled and receives the nicking at the point at which the wind emerges from the foot of the pipe. The three types of languid are shown on p. 18. (See also DOUBLE-LANGUID.) The block of the wood pipe is sometimes called a languid, especially when it is formed in the Pendleburian manner. The word means "a little tongue" (c.f. French *languette).* (See also QUICK and SLOW SPEECH.)

LEAF.—The flatting of the upper lip of a metal flue pipe. When the leaf is pointed at the top, it is known as a "bay leaf"; when it is rounded or arched, it is called a "French leaf."

LEATHERED LIP.—Having the upper lip coated with thin leather or split-skin. When the lower lip is so treated, or when both lower lip and languid-bevel are covered with leather, the pipe is said to have a "clothed flue."

LEATHERED SHALLOT.—Having the face of the shallot lined with thin leather so as to prevent the tongue striking against brass. This is never necessary.

LIGHT PRESSURE: LOW PRESSURE.—See HIGH PRESSURE.

LIPS.—The upper and lower edges and flatting of the mouth of a flue pipe. See diagram of metal pipe on p. 18, where the lips are marked *e f*. See also QUICK and SLOW SPEECH.

MITRE.—A joint formed in the body of a pipe at an angle from the vertical line so as to reduce the height of the pipe without affecting its speaking length. The flue pipe is mitred by having the top turned over at right angles: if a second turn at right angles to the latter be introduced, this is called a "double mitre." The reed pipe is mitred by having the *lower* part of the tube curved round loop-wise as shown on p. 59. If the top of the tube be turned over at right-angles, this is called "hooding," as it is not a device for reducing the height but for preventing the access of dirt.

MOUTH.—The quadrangular aperture (including the interior cavity) between the upper and lower lips of a flue pipe. It is at this point that the stream of pressure-wind emerging from the flue sets up static wave-vibrations. The area of the mouth is ascertained by the formula "width × height." The *width* of a metal pipe is measured in relation to the internal circumference of the pipe-body. (The circumference = the internal diameter multiplied by $\frac{22}{7}$, or 3·14159.) Suppose the pipe to be $2\frac{1}{4}$in. in diameter (say, the 2ft. length C of a diapason). If the mouth be 2in. wide, it will be two-sevenths of that pipe's circumference; if $1\frac{7}{8}$in. wide, it will be four-fifteenths of the circumference; if $1\frac{3}{4}$in. wide, it will be a fourth, and so on. Very seldom, however, is the proportion worked out to mathematical exactness by pipe makers whose flatting tools are often inaccurate in gauge, the tendency being to make the mouth-width narrower than is warranted by the mathematical term used. Thus, a "two-sevenths mouth" is more often than not a four-fifteenths or even a fourth width when accurately measured, and a fourth mouth is produced by a two-ninths flatting tool, though it may be *called* a "fourth." This point is mentioned because of its importance, and because not only ought voicers to be on their guard against such inaccuracies, but also credit is due to those pipe makers who are punctilious in the observance of these rules. The general rule in regard to the width of mouth in a wood pipe is to make it the same as the width of the plank on which the mouth is placed. (See p. 78 for further information on this question.) The *height* of the mouth (known as the "cut-up") is measured in relation to its width. (Sometimes in the case of the metal pipe in relation to the pipe's internal diameter.) Supposing the width of the mouth to be 2in., and its height to be $\frac{1}{2}$in., it is then said to be "cut up a fourth." The

following is a list of the proportions generally used by voicers in the cutting up of metal pipe mouths. In wood pipes of flute tone the height of the mouth is sometimes greater than its width, while small scaled stopped metal pipes may be cut up the same height as the width of the mouth.

HEIGHT.			TYPE OF PIPE SUITABLE.
4th	cut up	(4 in 1)	Dulciana, Salicional, Mutations.
$3\frac{3}{4}$	,,	(15 in 4)	Geigen, Octave Diapason ranks.
$3\frac{1}{2}$	,,	(7 in 2)	Diapason.
$3\frac{1}{4}$	,,	(13 in 4)	High-pressure Diapason, Harmonic Flute.
3rd	,,	(3 in 1)	Viola and Quintaten.
$2\frac{3}{4}$	,,	(11 in 4)	Bass of Viola and Diapason.
$2\frac{1}{2}$	,,	(5 in 2)	Flute (non-harmonic).
$2\frac{1}{4}$	,,	(9 in 4)	Gedackt (large scale).
$\frac{1}{2}$	,,	(2 in 1)	Lieblich Gedackt (minimum) and Rohrflöte.

NICKING.—The minute incisions or notches cut by the voicer's nicking tool into the lower edge of the languid-bevel of a metal flue pipe, and into the top edge of the block of a wood pipe. The lower lip is often nicked at the same time, though these edges are actually independent of each other in respect of nicking. The appearance of nicking somewhat resembles the teeth of a tenon or sash-saw. Curiously enough, despite the free use that has been made of human face terminology in the description of the various parts of an organ pipe, the obviously dental character of the nicking has not induced anyone to adopt the name suggest by this terminology. The primary object of nicking is to eliminate from the initial speech of a pipe certain anticipatory extreme overtones which are far from agreeable. The nickname for this distressing phenomenon is "buzzing" or "spitting." With the inverted form of languid, as with the German type of wood block, nicking is not required; nor is it so imperative with the earliest form of languid with its fifteen degrees bevel-edge. But with the acute-bevelled languid of modern use, especially when the lower lip is dubbed inward (thus forming a convergent flue), the absence of nicking spells disaster to the voicing. The greater the amplitude and frequency of the vibrations of the wave front at the mouth, the more imperative the nicking, which exercises a wholesome restraint upon these eddy currents.

NODE - HOLE.—A small circular hole, about $\frac{1}{16}$in. diameter to $\frac{1}{8}$in., bored in the middle of a flue pipe-body, or more strictly at the point of vibrational rest. (See SPEAKING LENGTH.) When an open flue pipe is so treated at the mouth that the octave above the normal pitch of the pipe sounds (this phenomenon is achieved by making the mouth quite low and pulling the upper lip outward), it is still possible to produce the prime tone by blowing very gently into the pipe. If, however, a nodal hole be pierced in the centre of the pipe-body (measuring the distance about half way between the upper lip and the top of the pipe), provided the hole does not exceed $\frac{1}{8}$in. in diameter, the pipe will be found to speak (gently blown) the minor seventh below the octave (that is, a whole tone above the prime) before

flying up to the octave or first upper partial. Add another hole in the vicinity of the first one, and the anticipatory note will be a minor sixth below the octave, a third hole will convert the sixth from minor to major, a fourth hole will produce a perfect fifth between the hum note and the harmonic, and so on. In voicing harmonic imitative flutes, the sixth would seem to be the pleasantest hum note to induce, but this is a detail which a voicer must decide for himself.

OPEN SHALLOT.—The form illustrated in Fig. C of the diagrams of the reed shallot on p. 66. (See SHALLOT.)

OPEN SOUNDBOARD.—A soundboard not enclosed in a swell box. (See ENCLOSED.)

ORIFICE.—(*a*) Any aperture or inlet through which pressure-wind flows or is discharged, such as the pallet-hole, foot-hole, flue, &c. (*b*) The opening of a reed shallot (*q.v.*).

OVERBLOWN.—When an organ flue pipe is forced by an excess of wind discharged through the foot to speak a harmonic other than the prime note. The mouth and languid of the pipe may be so adjusted as to render quite unnecessary the admission of a large supply of wind at the foot, in which case the pipe is predisposed to overblow or "fly off" to an upper partial tone. In reed voicing the term is not a happy one to use, the wind supply having no direct influence on the *harmonic* treatment of the pipe. (See also QUICK SPEECH.)

OVERTONES.—The *upper* partial tones of a musical note. (See HARMONIC 1). The partial tones include the prime or ground tone.

PALLET PRESSURE.—The pressure of wind as it flows through the pallet-hole of the soundboard in contra-distinction to the pressure of the wind flowing up the foot or boot of the pipe.

PARTIALS.—The term used by Helmholtz for the serial harmonics of a musical note. (See HARMONIC 1.) In reading text books on tone care must be taken to distinguish between "partials" and "upper partials." The partials of a note include the prime tone, while the upper partials exclude it. Thus, the twelfth is the third partial, but the second upper partial or overtone.

PIPE-BODY.—The substance of the flue pipe above the languid. (See SPEAKING LENGTH.) Also the tube of the reed pipe may be so designated.

PITCH.—The vibration-number of a sound; the degree of its acuteness or of its gravity. There are three varieties of absolute pitch now in use, which form the basis of organ tuning. They are as follows:

Diapason Normal (modern Continental)	middle A = 431 vibrations per second.	
	treble C = 517·3 ,, ,,	
New Philharmonic	middle A = 435 ,, ,,	
	treble C = 522 ,, ,,	
Society of Arts	middle A = 440 ,, ,,	
	treble C = 528 ,, ,,	

The old Philharmonic pitch of C 540 has now rightly been discarded. The temperature at which these pitch numbers are reckoned is assumed to be 60° Fahrenheit. The ratio of A to C is as 5 : 6.

PLAIN METAL.—When the percentage of tin in the alloy of pipe-metal falls below 35%, and no spots appear on the surface, the metal is known as "plain." A good percentage for the tin in plain metal is 20%, but excellent pipes for diapason work can be made with 15% tin, and a *little* antimony to stiffen the alloy.

PLUGGING.—The foot-hole of a wood pipe is reduced in area by the insertion of small plugs of wood, the wind passing through the interstices thus formed.

PRESSURE OF WIND.—The potential energy of air compressed and discharged into the pipe from the reservoir and through the pallet-hole in the soundboard. (See HIGH PRESSURE.) Wind pressures vary in organ building from 1½in. to 50in. by the wind gauge. If wind is discharged into a sealed chamber or trunk, the pressure remains constant ; but if there is an outlet communicating with open air through which the wind is flowing, the pressure diminishes as the wind approaches the orifice, and the larger the orifice (i. e., the bigger its effective area), the greater and quicker the fall in the pressure until, as in the case of the removal of the faceboard from a wind-chest, there is no pressure at all.

QUICK SPEECH.—An expression used by voicers to denote the tendency of a flue pipe to overblow to a harmonic. This condition may be created by (1) too low a mouth, (2) too convex an upper lip (i. e., pulled outward too far), or (3) too low a position for the languid. Under certain conditions too narrow a flue will favour quick speech. These factors all bear an intimate relation to the quantity of pressure-wind admitted to the foot of the pipe and their adjustment is influenced thereby. Quickness of speech and also diplophonia (double speech, nicknamed "coughing") are caused by insufficient wind supply at the pipe foot in proportion to the area of the pipe-body and the mouth. The reason for this phenomenon is that the foot-hole is too small to allow the pressure-wind to fill up the chamber (for this is what the foot actually is) in the time requisite for full speech ; consequently, a comparatively feeble air-reed is produced in anticipation (the initial "cough" or "spit"). With an adequate wind supply at the foot, quickness of speech may be cured either by *(a)* adding a beard or bridge to the mouth of the pipe, in which case the quickness may be retained without its accompanying defects, or *(b)* the lips and languid may be readjusted to counteract the tendency of the pipe to overblow. (See also SLOW SPEECH.)

RANK.—A set of pipes forming a stop of a given compass, not necessarily complete. The term is used when two or more sets of pipes are associated with each other, such as the *céleste* and the mutation ranks.

REED. — Strictly, this is the name for the shallot *(q.v.)*, but by *synecdoche* the part has given its name to the whole, and the word *reed* represents the complete pipe. (See also FLUE PIPE.) The different parts of the reed pipe are shown in the diagram on p. 66. The discharge of pressure-wind through the hole in the boot sets the brass tongue in vibration, which in its turn rapidly covers and uncovers the triangular orifice of the shallot. The periodic impulses of wind thus admitted to the interior of the shallot and thence to the pipe do not in themselves produce the tone, but they exert suction upon the body of air in the shallot and lower portion of the tube; the actual note is produced by the vibrating tongue itself, just as the note is produced by a vibrating string. The tube acts as a resonator, which amplifies the original note and converts it into musical tone. The pitch of the tongue-note is a little higher (usually from half to a whole tone higher) without the resonator than that of the complete pipe.

REGISTER.—The compass of the organ is divided into four main portions or registers, namely the bass (CCC to BB), the tenor (TC to B), the middle (middle C to B), and the treble or upper register (treble C to top C). It is the object of the voicer to secure regularity (not always uniformity) of tone and power through all the registers by careful and artistic grading of scales. (See SCALES.)

RESONANCE.—"Sympathy aiding original force" (Hermann Smith).

RESONANT BUILDING.—A building in which an organ is surrounded by highly favourable conditions due to the responsiveness of the materials of its construction to sound waves, thus amplifying and enhancing its tonal output and effectiveness. It is not too much to say that an organ owes at least seventy per cent. of its effectiveness to its environment. Non-resonant conditions are mainly caused by *(a)* absorbent material, *(b)* "sound pockets."

ROLLER: ROLLER - BRIDGE.—See BRIDGE.

RIPIENO.—This is an Italian word meaning "full," and refers to harmonic amplification for special dynamic effects in musical composition and orchestration. In organ tonal design this term is applied to the type of mixture that corroborates the natural overtones and adds brilliance to the chorus.

SCALE.—(1) The absolute diameter of the top of a metal pipe, or the area of a wood pipe, measured inside. (2) The graduated scheme of relative proportions by which a series or stop of pipes is accurately constructed so as to present a uniform and regular result throughout the series. (See HALF MEASURE.) (3) The scheme of grading the progressive sizes of the various parts of a pipe, such as the area of mouth, length of body of a flue pipe, the

size of shallot and tongue, diameter of shallot and tube at their respective tips; length of tube, size of boot and block of a reed pipe. Also the grading of the thickness of the pipe-metal, and of the reed tongues. (4) The compass of a stop of pipes, such as CC to C^4. But the word "compass" is better than "scale" when speaking of the range of a stop, thus avoiding possible confusion of terms.

SHADE.—A hinged lid or cap of metal affixed to the top of a pipe for tuning and regulating purposes. Open wood pipes are usually tuned by the adjustment of metal shades: one end of the shade is fitted and glued into a saw-cut on the top of the back plank and then bent over to form a lid. Metal shades soldered on to the top of a reed tube are called "caps," and if free for adjustment at one end are called "half-caps." (See also CAP.)

SHALLOT.—The part of the sound-apparatus of a reed pipe to which the tongue is attached and against which the tongue strikes during the process of vibration. It is a semi-cylindrical tube of brass slightly tapering from base to tip, closed at its lower end with a disc, and open at the other and narrower end. This latter portion, to the extent of a fourth of the total length of the shallot, is accurately fitted into the block-hole. The face of the shallot on which the tongue rests is a perfectly flat and smooth surface; on this face an opening is cut, the shape of the opening differing in various types of shallot. It is the function of the tongue to cover and uncover this opening in rapid alternation. There are three principal types of opening, and they are shown in the diagrams on p. 66. The *open* shallot is the oldest form of all, the original specimens having parallel sides, and not tapering as illustrated in the diagram (*c*) which represents the more modern type. The *closed* shallot (*d*) is the most general in use, the opening being in the form of an isosceles triangular, known as "V-shaped." The actual length of this opening as well as the width of its base varies with the requirements of the voicer. In diagram (*b*) the opening is closed but shown higher up the shallot. This is called a *filled in* or *capped* shallot, the lower end of the opening being covered with a thin brass plate specially shaped to fit in its place. To quote the words of the inventor of this shallot (Vincent Willis), "the removed head reduces the influx of compressed air and lengthens the period between the influxes." The small narrow shallots used for the orchestral oboe stop have their base bevelled as indicated by the dotted line in the diagram of the section of a reed pipe. The shallots of big reed pipes (in the 32ft. and 16ft. octaves) are sometimes made of hard wood and faced with leather.

SIZE OF DISCHARGE.—See AREA OF DISCHARGE.

SLIDE.—A small tube of tin formed by hammering a flat piece of tinplate round a mandrel so that the ends meet or slightly overlap: this tube is then sprung on to the top of a cylindrical metal pipe which it clips firmly, and being capable of adjustment up or down, enables the tuner to vary within prescribed limits the length of the pipe after the fashion of a telescope, thus flattening or sharpening it as required. When the pipe is slotted, the tin slide is made to cover a portion of the slot, the length of the slot being thus

adjustable. All metal flue pipes of the modern organ from tenor C (4ft.) to treble C should have these slides fitted on for tuning purposes, rather than be subjected to the tuning cone in the old-fashioned manner. Slides are also frequently fitted to the tubes of such reeds as the clarinet and vox humana.

SLOT.—A narrow, vertical, rectangular-shaped hole cut out of the top of a pipe at the distance of the pipe's diameter from the top. The flue pipe so treated exhibits a well-defined change of tone, due to the apparent reinforcement of certain upper partials. A reed tube is not similarly affected by the slot, which is merely cut (closer to the top of the pipe) for the purpose of regulating the power and consonance of the reed. (See CONSONANCE.)

SLOW SPEECH.—A term used by voicers to express the tendency of a flue pipe to "drag" its note into existence instead of speaking naturally, promptly and firmly. The faulty condition is produced by the languid being too much raised, by the upper lip being too concave (pressed inward), or by the flue being too wide; all these relative positions being determined by the quantity of pressure-wind admitted to the foot of the pipe and by the cut up of the mouth. Slow speech is also the result of an excessive supply of wind at the foot in proportion to the area of the pipe-body and the mouth. The reason for this is that the velocity of the wind discharge is too high in proportion to the rate and amplitude of the vibrations in the pipe-body. In slow-speaking open flue pipes the twelfth is usually too prominent a feature of the *timbre*, just as in quick-speaking pipes the octave is unduly present. The expression "slow speech" is also applied to the *correct intonation* of pipes of the diapason class (see p. 16) and is then synonymous with *cantabile* or singing tone. The term is used in this connection because in the production of true diapason tone the adjustment of the lips and languid is such that it creates a *tendency* to slowness rather than quickness of speech, the upper lip being concave and the languid kept high. In other words, the tendency of the pipe to overblow to its octave is reduced to a minimum consistently with prompt speech. (See also QUICK SPEECH.)

SOCKET.—Synonymous with reed-boot, but sometimes applied to the boot, sound-apparatus and tip of a bass reed pipe from which the tube is detachable. (See BOOT.)

SPEAKING LENGTH.—The body of a flue pipe, measured from the mouth (properly the languid) to the top. When the pipe is sounding, this body encloses, or rather surrounds, a vibrating column of air, which is subjected to an alternating process of condensation and rarefaction. The air-column of an open pipe is divided into two parts separated by a node or rest-point, which is situated a little below the middle of the pipe-body. During the process of condensation, the two parts of the air column are impelled towards each other, while during the process of rarefaction they are drawn apart, the pulse-motions acting somewhat after the manner of a concertina. When the pipe is overblown to speak the octave (as in the case of the harmonic flute) the air-column is divided into *three* parts separated by two nodes, the central part (or "ventral segment") being equal in length to the

sum of the other two. It is just as if the node had been split in two and each part had separated from the other at an equal distance from the centre, and indeed this is what does happen when outside atmosphere is directed on to the node through a small hole pierced in the middle of the pipe. When the pipe is overblown to sound the twelfth (the next partial above the octave), the air-column is divided into *four* parts separated by three nodes. Divide the air-column into five parts separated by four nodes and the fifteenth or superoctave is isolated, and so on through the series of harmonics. In the case of a stopped pipe the stopper takes the place of the upper part of the divided air-column in an open pipe, the node being situated at the stopper, so that no division occurs while the fundamental note is sounding. When the pipe is overblown to its first upper partial (the twelfth), the air-column is divided into two, separated by a node situated a little below the middle of the pipe-body, and if the seventeenth be isolated the division of the air-column is three-fold, and so on. The speaking length of a flue pipe must be increased in proportion as its diameter or scale diminishes, if the same pitch-note is to be maintained. The following mathematical formula for ascertaining the length in inches of flue pipes (from the lower lip to the top of the pipe-body) may be found serviceable:—

$$L = \frac{6693}{v} - \frac{5}{3} D$$

where v is the vibration-number of the pipe (e.g., CC, in diapason normal pitch, gives 64·6 vibrations) and D is the internal diameter (i.e., the scale) of the pipe-body. By this formula we find that the speaking length of the CC diapason pipe, whose scale is 6in., will be 7ft. 9·6in. (diapason normal); that of the CC dulciana, whose scale is $3\frac{1}{4}$in., will be 8ft. 2·2in. The temperature must be assumed to be 60° Fahrenheit.

SPEAKING PRESSURE: SETTLING PRESSURE.—Synonymous with "effective pressure" *(q. v.)*.

SPEAKING ROOM.—A sufficient space in which a pipe (more particularly an open flue pipe) may speak free from the interference of other bodies or pipes in its vicinity. The effectiveness of an organ is largely dependent on this condition, as Schulze and Father Willis both knew full well. This rule does not apply so strictly to stopped pipes, nor are reeds so susceptible to the evil influence of "crowding."

SPOTTED METAL.—An alloy of pipe-metal containing a minimum of 35% of pure tin. The best spotted metal contains from 45% to 55% of tin, but when used for the larger scaled pipes an extra thickness of metal is required. The thicker the metal, the smaller the spots showing on the outer surface. Spotted metal is mostly used for viols and small scaled pipes, though at one time an organ containing anything else except tin or spotted metal for its metal pipes was considered the work of a jerry builder. *Good* plain metal, and (for the big bass pipes) *good* zinc are superior to spotted metal for diapason work and for all stops that require really stout pipes.

STATIC WAVE-VIBRATION. — The vibrating stream of wind at the mouth of a flue pipe which creates what is known as the "air-reed." It is called "static" because it is a balanced reciprocating process set up at one particular point, namely the "imperfect orifice" of the flue.

STOPPER.—The wooden plug that is fitted into the top of a flue pipe and closes that end of the body. It is lined with leather so that it may fit "air tight," and at the same time may be sufficiently free for movement up or down for tuning purposes. Metal pipes are best stopped with a cork-lined stopper, as cork is more elastic and does not press unduly on to the metal.

STRIKING REED.—See Beating Reed.

STRING TONE.—The class of flue tone in which the upper partials or overtones are most highly developed. Also called "viol tone."

STRINGY.—Possessing the characteristic tone of the string class.

SWELL BOX.—The chamber in which the expressive divisions of the organ are enclosed, the expression being obtained by the gradual or sudden opening or closing of a series of shutters or louvres. The modern organ possesses at least two swell boxes, which are essential to the proper rendering and interpretation of modern music. Performers to-day rely more and more on the "flexible expression" of two or more swell pedals in the art of transcribing and reproducing orchestral effects on the organ. Not only ought the *crescendo* and *diminuendo* effect to be as marked as possible, but the slightest movement of the swell pedal (i. e., of the shutters) from the closed position should release the imprisoned sounds to an extent proportionate to the degree of motion. Also the swell box is in no sense (to quote Dr. Audsley) "an annihilating chamber," and therefore there is a limit to the thickness of its walls. With a view to securing the greatest possible *crescendo* and *diminuendo*, there are three great rules in the construction of the box which may be laid down: (1) the shutters must be absolutely tight-fitting; (2) the whole of the interior of the box, including the shutters, must be rendered absolutely non-absorbent and non-porous so as to act as sound reflectors; and (3) no angular corners or pockets should be allowed inside the box, especially at the back opposite the shutters. With the fulfilment of the above conditions it is hardly necessary to resort to bricks and mortar in lieu of the time-hallowed wooden panels of two to three inches' thickness. Stops intended for enclosure in a swell box require very different treatment in voicing and finishing from those placed on an open soundboard, for obviously the box will act as a damper upon all pipes enclosed in it, and due allowance must be made for this condition, which varies in accordance with the special construction of the box and the position it occupies in a building.

SYMPATHY.—This is a well known phenomenon to tuners and is occasioned by the attempt to tune a soft-toned pipe, such as the dulciana, to a much louder one such as the diapason or principal. The weaker pipe is drawn into tune with the stronger by the temporary absorption of its sound waves, but actually the weaker pipe may not be consonant with the pitch of

the organ. Such stops are always tuned "to themselves," that is, to their own bearings, just as a pianoforte is tuned. The term "sympathy" is also applied to the evil effects caused by the overcrowding of pipes on a sound-board, which makes fine tuning almost impossible.

THROAT.—The front portion of the block of a wood pipe, which with the interior of the cap forms a narrow channel for the wind as it passes from the foot to the flue.

TIMBRE.—The French term for tint or tone-colour. The characteristic quality of tone produced by a pipe or stop of pipes which distinguishes it from all others.

TIP.—The narrow extremity of (*a*) the tube, (*b*) tongue, or (*c*) the shallot of a reed pipe. (See also HEAD.)

TOMPION.—Another name for stopper (*q.v.*). (French *tampon*, a bung).

TONGUE.—The thin, narrow strip of brass which is attached to the narrow end of the shallot face, leaving a free end to vibrate over the opening cut in the shallot. The tongue is made of fine, hard, elastic brass, well burnished; it is uniform in thickness and shaped to cover the face of the shallot accurately. See diagram of reed pipe on p. 66, where the tongue is marked (*d*); also the weighted tongue shown on p. 62. The subject of curvature is treated on p. 62. The *modus operandi* of tongue-curving may be briefly explained as follows: the tongue (in a perfectly flat state and well burnished with a fine file) is clamped at its narrow end on to a flat ebony block; a cylindrical rod of steel having a handle at each end is then used for making the required curve, the voicer passing this tool (burnisher) over the tongue from the tip to the head of the tongue (i.e., from the clamped to the free end) with a graduated increase of pressure. The stroke is a rapid one, and may be repeated as often as necessary until the exact quality and quantity of curve is attained. To diminish the curve of an over-curved tongue, the tongue can be burnished on a flat block of steel instead of wood, the steel being harder than the brass. There are various methods of finish-curving known to reed voicers which cannot be mentioned here: they are in the main applicable to the larger tongues only. The lengths, thicknesses and widths of the tongues required for a complete stop are accurately gauged by a formula or scale arrived at by many years of experience. Various gauges of sheet brass are stocked by the reed voicer: from these the tongues are cut to suit the requirements of any particular octave or series of notes and of the wind pressure employed. The length and width of the tongue is decided by the length and width of the shallot-face. (On the subject of shallot scaling see p. 69.) Dirt is very liable to find its way between the tongue and the shallot-face, and it then causes temporary "flats." The same result occurs if the reed is blown by the mouth, the moisture of human breath creating a series of small clots on the surface of the shallot. The *continuous longitudinal* vibration of the tongue must be safeguarded in every possible way.

TUBE.—The pipe-body of the reed, the tip or narrow end being soldered to the block directly over the hole at the other end of which the shallot is fitted. Thus the tube is a continuation of the tip of the shallot, the block separating the two. (See diagram of reed pipe on p. 66.) The tips of the tubes of the old builders were much too wide; the modern tip is practically the same diameter as that of the shallot tip as shown in the drawing above referred to. It is, however, legitimate to use a *comparatively* wide tip for the tube in special cases where, for instance, it is desired to produce a fairly powerful trumpet tone on a moderately low pressure from reed pipes enclosed in a swell box. In any case, the tips have to be scaled in proportion to the diameter or scale adopted for the tubes at the top, while the exact relation of the area of the tip to that of the top for any given stop is subject to slight variation in accordance with the quality of tone required. Normally, the proportion is from 1 : 10 to 1 : 11. The tube acts as a resonator (or rather as a "consonator") reinforcing and improving, under scientific use, the original note emitted by the vibrating tongue. It is, therefore, not a speaking body like the flue pipe, since it possesses no nodes or ventral segments.[7] That it controls the sound produced by the tongue is very obvious from the fact that without it no decent musical note is obtainable, and also from the fact that the application of various shapes of tube directly influences the *timbre* of the note. The relation of length to diameter is the exact opposite of that which obtains in flue pipes: the larger the scale, the longer the tube must be in proportion. It is the opinion of some that the material used in the construction of the tube is a question of trifling importance, since it is merely a resonator. The principal desideratum is to ensure adequate thickness of metal for the purpose of resisting the vibrations set up in the tube. (See p. 70 under TUBA MAGNA.) Granted the fulfilment of this condition, it does not seem to matter whether plain or spotted metal is used. But it is possible to employ too hard or too soft a metal, such as zinc or pure tin on the one hand and an undue percentage of lead on the other, these conditions affecting the degree of resonance in some subtle manner. Good thick plain metal is the safest for general use. Stout, hard-rolled zinc is permissible for the bass tubes, provided the lower portion (say, a third) from the tip is made of plain metal. Wooden tubes, inverted pyramidal in shape, are also used for large pipes.

TUNING SLIDE.—See SLIDE.

TUNING SPRING: TUNING WIRE.—The hooked wire of unannealed steel or phosphor bronze that holds the reed tongue against the shallot at any desired position, thus controlling the vibrating length of the tongue. By tapping the crook at the top end of the wire, up or down, the tuner is able to lengthen or shorten the vibrating end of the tongue and so flatten or sharpen the pitch of the note. The spring must be tensioned to the exact pressure required to hold the tongue in position during the process of vibration without shifting; at the same time it must be capable of moving

[7] The node is actually situated immediately *below* the tube, at the point at which the block separates the tube-tip from the shallot-tip, that is, it resides in the block hole. (See diagram on page 66, *b* to *c*.)

smoothly along the surface of the tongue when tapped by the tuner. In scientifically voiced high-pressure reeds, there is a definite "period" or margin within the limits of which the spring may be adjusted on the tongue without altering the pitch of the note. This is a safeguard against mild changes of temperature which affect the relationship between the tube and the tongue (see CONSONANCE). The tuning spring is marked *(e)* on the diagram of a reed pipe shown on p. 66.

VELOCITY OF VIBRATION.—The rate per second of the backward and forward (i.e., the pendular swing) motions of a vibrating substance.

VELOCITY OF WIND.—The speed or kinetic energy of wind under pressure in its discharge through trunks and orifices of varying sizes. The velocity increases with the increase of the effective area of the channel or of the orifice through which the mass of wind flows.

VIBRATION.—The rapid reciprocating motion made by a body when disturbed from a position of equilibrium, to recover that position again. Such is the swing of the pendulum, the vibration of the tongue of a reed pipe, and of the air-reed or wave-front of a flue pipe.

VIBRATOR.—A term used by some voicers for the tongue of a reed.

VOICING.—The fine art of adjusting the various parts of an organ pipe so as to obtain the precise quality and power of tone desired. The process of voicing passes through two stages, (1) the primary, when the pipe is roughly "put on its speech," and (2) the final, when the finishing and regulating of each pipe in the stop or series is executed. The first stage is the work of an experienced *mechanic*; the final stage can only be successfully achieved by an experienced *artist*, endowed with a highly cultivated and sensitive ear, enabling him to gauge the delicate *nuances* of *timbre* at their relative values, and to assign to each tone-colour its rightful place in a complete scheme.

V-SHAPED.—The triangular shape of the opening of a closed shallot is so designated owing to its resemblance to an inverted V. (See SHALLOT.)

WAVE.—An oscillatory motion of the component particles of air when disturbed from its position of rest by force or pressure.

WAVE-FRONT.—See AIR-REED, STATIC WAVE-VIBRATION.

WEDGE.—A small piece of hard wood used for securing the tongue of a reed pipe to the tip of the shallot. See diagram of reed pipe on p. 66, where the wedge is marked *(f)*. The wedge is rammed into a small hole bored in the block immediately above and meeting the larger hole bored for the reception of the shallot tip. The wedge is shaped so as to fit accurately and tightly in its hole: the underside is flat and level, the top is rounded and sloped to a thinner edge at the point of insertion in the hole. As the tongue and shallot have to be made removable for cleaning purposes, the wedge must be fitted in such a way that it can be easily withdrawn (levered out). while at the same time it is sufficiently tight to keep the tongue in its place even under the disturbing force of high pressure wind.

WEIGHT.—The small load which is attached to the head or end of a reed tongue in order to slow down its vibration rate, and thus enable the voicer to adopt a relatively shorter tuning length for the same pitch. Shortening the tongue means sharpening the pitch (and *vice versâ*, lengthening means flattening), and to sharpen the pitch is to make the tone softer and smoother, while flattening makes it louder and harsher. The effect of the weight is to restore the original pitch while retaining the smoother and "closer" tone of the shorter vibration-length of the tongue. Weights are not applied to the smaller tongues, though they are carried as far up the compass as treble C by some voicers when high wind pressures are employed, such voicers preferring to adopt felt weights (assisted by small pieces of lead for the larger tongues). The Willis brass weight is shown in the diagram on p. 62. It is screwed on to the tongue, the cone-point resting on the latter as illustrated. The smallest weight used (No. 1) measures $\frac{3}{32}$in. by $\frac{3}{32}$in. (diameter of top by height *minus* cone) and weighs a quarter of a gramme; the largest (No. 26) is $\frac{13}{16}$in. diameter by $\frac{13}{32}$in. height (*minus* cone) and weighs 32 grammes (1 $\frac{1}{16}$ oz.). On 7in. pressure the weighted tongues extend from the lowest note up to tenor F; on 12in. they extend up to tenor B (one note below middle C); while the 30in. tuba magna at Westminster Cathedral is weighted up to B below treble C.

WIND.—In organ building this term is always used to mean air under pressure, generated either by bellows-feeders or (the more modern way) by rotary fan-blowers; the wind being thus compressed is stored in reservoirs which are weighted or spring-tensioned at their top-boards to distribute the various pressures to various parts of the organ. Each reservoir is fitted with a roller-pallet or rocking valve (according to the design of the builder) which cuts off all supply from the main delivery (either from the fan or from a larger reservoir, as the case may be), as soon as the top-board of the reservoir has risen a certain height, thus preventing overblowing and unsteadiness of wind. It is essential, if good tonal results are to be obtained, that the wind should be perfectly steady and that there should be an ample supply of it at the soundboards to meet every possible demand from the voicer and finally from the player.

WIND PRESSURES.—See WIND. The term *pressure-wind* refers to air under pressure generally, while *wind pressure*re fers to a particular pressure of wind, such as 3in. or 20in.

WIND-WAY. — A term applied by some authorities to the *flue* or narrow passage between the lower lip and the languid (or block of a wooden pipe). Properly speaking, however, the wind-way is the channel which extends the whole distance of the pipe-foot and ends at the mouth, that part, in fact, in which the effective or speaking pressure is measurable. The flue, therefore, is the upper extremity or "imperfect orifice" of the pipe-foot, the wind-way being the connecting channel or trunk between the foot-hole and the flue, including the latter.

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